THURSDAY, MAY 12, 1887.

THE AINOS.

The Language, Mythology, and Geographical Nomenclature of Japan viewed in the Light of Aino Studies. By Basil Hall Chamberlain. Including an Ainu Grammar by John Batchelor, and a Catalogue of Books relating to Yezo and the Ainos. (Memoirs of the Literature College, Imperial University of Japan, No. 1, 1887. Published by the Imperial University, Tōkyō.)

THE Ainos have long been a puzzle to the philologist and ethnologist. Their place amongst the races of the world, living or extinct, has been, and remains, unsettled; and their relations to the present inhabitants of the Japanese archipelago, though the subject of frequent discussion in recent years in Japan, form an unsolved problem. Like fragments of races still existing in various other lands, the Ainos refuse to fit into any ethnological scheme, and are waifs and strays in science much as they are in the world around them. The main cause of this, no doubt, is that so little has really been known about this curious race. A certain amount of knowledge has been repeated by one writer after another, but that invaluable instrument of investigation, the Aino language, has stood outside the pale of philology. The writer of this very important and interesting monograph does not attempt to answer the questions arising out of the presence of the Ainos in Yezo, the Kuriles, and Southern Saghalien; his object is, "by comparing the language and mythology of the Ainos with the language and mythology of the early Japanese, to ascertain what sort of relationship, if any, exists between the two races, and to shed light on the obscure problem of the nature of the population of the Japanese archipelago during late prehistoric times." His equipment for this interesting task is a profound knowledge of the Japanese language and mythology—"which, in the absence of a thorough practical knowledge of Aino itself, is the first condition of the successful investigation of any subject connected with the Island of Yezo"—and travel and investigation, especially in regard to their myths, amongst the Ainos themselves. He has also associated with him in the work the Rev. John Batchelor, of the Church Missionary Society, who has published in the present monograph a grammar of the Aino language, and whose "five years' intercourse with the Ainos in their own homes, and close study of the language as it falls from the lips of the people, enable him to speak with an authority belonging to no other investigator." The result of this co-operation is the work before us, and perhaps the best method of reviewing it is to explain the method followed by Prof. Chamberlain in his investigation, and the results at which he has arrived.

First, then, he compares the Aino language with the Japanese. The close and intimate resemblance between the two is only superficial, and vanishes as soon as they are carefully compared. "The paradox of two races so strongly contrasted speaking related languages has no foundation in fact." Then follows a list of fifteen salient points of difference between the Japanese and Aino linguistic systems. Some of these, the writer says, may not be appreciated at their true value by scholars accustomed exclusively or chiefly to the study of the Aryan family of languages, whose looser structure allows of such wide divergences between the various members of the family. "But the Altaist, knowing the iron rule which forces all the Tartar tongues into the same grammatical mould, however widely their vocabularies may be separated, will hold the opinion of fundamental want of connexion between Japanese and Aino, until very strong arguments shall have been brought forward on the other side," and he proceeds to point out that on thirteen of the fifteen points of difference there is absolute identity between Japanese and Corean. As for the points of similarity between Japanese and Aino—such as the same construction of the sentence, and nearly the same phonetic system—Prof. Chamberlain suggests the long contact between the two peoples; but the borrowing, if borrowing there be, must have been on the side of the Ainos. On the whole, he is inclined to accept the theory of Von Schrenck, in his work on Amur Land, that Aino is to be regarded as a language altogether isolated at the present day, and "when it is remembered that the Aino race is isolated from all other living races by its hairiness and by the extraordinary flattening of the tibia and humerus, it is not strange to find the language isolated too." He treats with ridicule the suggestion that the Aino may be an Aryan tongue.

Next he comes "to that of which language is the vehicle—to the religion, the traditions, the fairy-tales of the two nations. Do the Ainos account for the origin of all things after the manner of their Japanese neighbours? Do Aino mothers and Japanese mothers lull their little ones to sleep with the same stories?" Japanese mythology is almost all to be found in the *Kojiki*, a work of the early part of the eighth century of our era, a literal translation of which, by Prof. Chamberlain himself, was noticed in NATURE a few years ago. With regard to the Aino myths, as there are no Aino books of any sort, these have to be obtained orally, by a tedious process of listening to successive story-tellers, for the brain of the Aino soon tires. The writer gives the results side by side: on one side the Japanese account of the Creation, of their origin, of the origin of civilisation, of the aborigines, of heaven and hell, the sun and moon; and then the Aino myths on similar subjects. In addition, a large number of stories of both peoples, relating to such subjects as Rip Van Winkle, the Isle of Women, a visit to the underworld, various beast-myths, stories about monsters, the causes of the peculiarities of natural objects, &c., are related—sometimes side by side for purposes of comparison; sometimes only the Aino version is given, the corresponding Japanese tale being readily accessible elsewhere. It will be seen from this bare outline of the contents of this section that a new world of folk-lore is here opened to the study of inquirers into this branch of research. The general conclusion at which Prof. Chamberlain arrives after this comparison of the two mythologies is that there is even less connexion between them than between the two languages. The stories could scarcely be more divergent in general complexion. The Japanese stories "are myths pure and simple, airy phantoms of the imagination," and have no moral tendency whatever. Japanese commentators on their own myths, struck with

the absence of morality in them, account for it by saying that their countrymen needed no moral teaching, because they were perfect already, and not depraved like the Chinese and foreign nations generally. The tales of the Ainos, on the other hand, generally point a moral or account for some natural fact. Birds and beasts are the characters; those of the Japanese are generally men, or gods who are the counterparts of men.

The third line of investigation adopted by Mr. Chamberlain is that of place-names in Yezo and in Japan. His first process was to make a catalogue of the names of the principal places in Yezo, with their Japanese corruptions, and the Chinese characters used by the Japanese in writing them. From this he compiles a kind of key, composed of Aino words contained in the names of places in the previous list, and common Aino designations for features of the landscape, such as are likely to occur in the names of places, their meanings, and the Japanese pronunciation. This he applies to the place-names of Japan proper in order to test whether they are of Aino origin. By this ingenious, elaborate, and toilsome method, Prof. Chamberlain examines numbers of Japanese geographical names in various parts of the country, with an amazing profusion of learning. We can do no more here than give the broad results, which are sufficiently clear and striking. He can say with certainty that names, as to the Aino origin of which there can scarcely be a question, may be traced right through the main island of Japan into the two great southern islands. They are fairly abundant even in the extreme southern province. The inference to be drawn from this is that the Ainos were the true predecessors of the Japanese all over the archipelago. "The dawn of history shows them to us living far to the south and west of their present haunts; and ever since then, century by century, we see them retreating eastwards and northwards, as steadily as the American Indian has retreated westwards under the pressure of the colonists from Europe."

It will be observed that Prof. Chamberlain comes to this conclusion, after a comparison of the languages, mythologies, and place-names of the Japanese and the Ainos; it is likewise the conclusion at which Prof Milne arrived a few years ago along a different line of investigation. The latter gentleman compared the kitchen-middens, stone implements, and other prehistoric remains found in numerous parts of Japan with those of undoubted Aino origin—some of the middens being even now in course of construction in Yezo. Prof. Milne's papers on the subject will be found in the Proceedings of the Anthropological Society for 1881, and of the Asiatic Society of Japan (vol. viii. Part 1, and vol. x. Part 2). Hence it may be taken as established sufficiently for all practical purposes that the pre-Japanese inhabitants of the Japanese islands were the Ainos. Beyond this conclusion we are not taken either by Prof. Milne or by Prof. Chamberlain, and with it we must be content until scholars have carried out that series of linguistic comparisons which is "the surest key for unlocking the mysteries of racial affinity and race migrations in this portion of Asia," of which Prof. Chamberlain's work is the beginning.

The last word is very far indeed from being yet said about the Ainos. Meanwhile their numbers are growing smaller decade by decade, their industries are passing into Japanese hands; the animals which were their principal sustenance are rapidly becoming extinct; the survivors of this people almost all speak Japanese as well as their own tongue, and are losing their special characteristics. Hence they "must without delay be subjected to all the necessary scientific tests: their language must be analysed, their folk-lore registered; for soon there will be nothing left." Prof. Chamberlain does not share the regrets of those who mourn over the *Japonisation* and approaching extinction of the Ainos. They have had abundant opportunities of improvement, but they have not profited by them. The son of the greatest living Aino chief is glad to brush the boots of an American family in Sapporo. This is how their latest investigator concludes his interesting and instructive monograph:—"The Aino race is now no more than a 'curio' to the philologist and to the ethnologist. It has no future, because it has no root in the past. The impression left on the mind after a sojourn among the Ainos is that of a profound melancholy. The existence of this race has been as aimless, as fruitless, as is the perpetual dashing of the breakers on the shore of Horobetsu. It leaves behind it nothing save a few names." The whither of the race is unhappily only too certain; its whence still remains a question to perplex the ethnologist, and, if present indications are to be trusted, it will continue an unsolved problem for many years to come. Prof. Chamberlain's monograph carries us just one step back in the life-history of the race; behind that, all is still darkness and doubt.

THE ZOOLOGICAL RESULTS OF THE "CHALLENGER" EXPEDITION.

Report on the Scientific Results of the Voyage of H.M.S. "Challenger" during the Years 1873-76 *under the Command of Capt. G. S. Nares, R.N., F.R.S., and of the late Capt. F. T. Thomson, R.N.* Prepared under the Superintendence of the late Sir C. Wyville Thomson, F.R.S., &c., and now of John Murray, one of the Naturalists of the Expedition. Zoology—Vol. XVII. (Published by Order of Her Majesty's Government, 1886.)

VOLUME XVII. of the Zoological Reports of the voyage of the *Challenger* contains three memoirs. The first is the second and concluding Part of the Report on the Isopoda collected during the Expedition, by Mr. Frank Evers Beddard, of which the first Part was published in 1884, and dealt exclusively with the family of the Serolidæ. The collection of Isopoda made during the voyage was very rich in new species and genera, more particularly in the deep-water forms, of which no less than thirty-eight are described as new. Among the shallow-water species the greater number of novelties were dredged off Kerguelen and the adjacent islands, adding no less than fifteen new species to the previously short list known. In other parts of the world, with the exception of Australia, dredging in shallow water did not yield any considerable number of species of the group. Many of the species described as new were previously briefly diagnosed by the author, in the Proceedings of the Zoological Society of London. Passing from the description of the species of this exceedingly interesting group of Crustacea

to the summary of their distribution, we find that, while the 300-fathoms line marks approximately the boundary between what may be called the deep-sea and the shallow-water species, yet there is no trace of any zone of depth that has not its Isopod fauna. From 345 fathoms down to 2740 fathoms, species were dredged continuously; there was nowhere a break of more than 100 fathoms. In passing from the lesser to the greater depths, there is evidently a decreasing number of species that are common to these depths and to shallow water; but it is impossible to draw an absolute line of division which would separate an abyssal from a shallow-water fauna. Of the seven species found at a depth of 2000 fathoms and upwards, two range into lesser depths, another (perhaps two) into shallow water, leaving only three distinctly abyssal forms.

One of the most important results of these investigations has been to show that ocean regions cannot be marked out with anything like the same definiteness as can the terrestrial areas. Among the Isopods the same genus, and even the same species, is often to be found in the most widely separated areas: thus, *Eurycope fragilis*, found in the North Pacific, near Japan, ranges as far south as lat. 60° S., close to the Antarctic ice-barrier and to the neighbourhood of the Crozets. It would also seem that the deep-sea Isopods are distributed very unevenly over the floor of the ocean. In long stretches of ocean—occurring, for instance, along the whole of the Central and Southern Atlantic, and the Central and Western Pacific—no species were found; but in drawing conclusions from such negative evidence, the imperfection of the record must be borne in mind. Among the Isopods thirty-four of the deep-sea species were found to be totally blind, and three others, unfortunately only represented by fragments, may in all probability be added to the list. In four more the eyes were evidently degenerate. On the other hand, in eighteen species, there were well-developed eyes. It must not be forgotten that certain shallow-water species are blind. Possibly, the author thinks, the explanation of these anomalies is to be sought for in the length of time that has elapsed since the migration of the different species into the abyssal regions of the ocean. This excellent Report is illustrated by twenty-five plates.

The second memoir in this volume is a Report on the Brachyura, by Mr. Edward J. Miers. We learn from the very modest preface to this really important contribution to the natural history of the brachyurous Crustacea that the groups richest in new genera and species were the Oxyrhyncha (Maioidea) and the Oxystomata (Leucosoidea), and to these belong most of the new forms collected at depths exceeding 100 fathoms. No brachyurous crab was found at a depth exceeding 2000 fathoms and but very few at depths exceeding 500 fathoms. The localities furnishing the greatest proportion of new or interesting forms were the stations at, among, or near the islands of the Malaysian archipelago, and at the Fijis. An atlas of twenty-nine plates accompanies the Report.

The third Report is by the late Mr. George Busk, F.R.S., and is on the Polyzoa, being Part 2, treating of the Cyclostomata, the Ctenostomata, and the Pedicellinea. With this memoir we propose to deal in a separate article.

THE ELEMENTS OF ECONOMICS.

The Elements of Economics. By Henry Dunning Macleod, M.A. Two Vols. (London: Longmans, 1886.)

WE should have been disposed to speak more kindly of this work upon a much troubled subject—a subject, nevertheless, affecting the happiness of the whole of human society—if we had not read in the letter of dedication that the author claimed to offer to his Right Reverend patron "a new inductive science; a new body of phenomena brought under the dominion of mathematics; a new order of variable quantities brought under the theory of variable quantities in general: the great science of analytical economics." Since recently it was an accepted theory among its students that at present there is no "science" of political economy, we were prepared to find a new revolution-working theory of the whole subject, and were surprised to find that the title sufficiently expressed the general contents of the book. The writer goes to the very elements of the science, building up from the beginning in the clearest of language, and illustrating by means of the derivation of words and of many legal phrases and customs, both ancient and modern, English and foreign, "the great science of economics." Mr. Macleod fiercely assails the opinions of Ricardo and other writers, but much of the error he attacks is only apparent. In economic language, there is no such thing, perhaps, as intrinsic value; nor does cost in all cases fix value, as every proprietor of superseded machinery, or of goods gone out of fashion, knows too well; yet it is misleading to teach that the fixing of value by cost may not be accepted as a fair working rule. In the ordinary state of any trade, 95 per cent., say, of the price will be fixed by the cost, and 5 per cent. by the state of the market; and if some such proportions as these are exceeded, increased or decreased production will soon restore them.

Mr. Macleod urges the claims of perpetual copyright, but we cannot see his distinction between property in that and in a patent. If patents are inconvenient for those whom they restrain, copyright is also inconvenient to men wanting cheap literature. An excellent argument to show how much (market) "value" arises from demand is drawn from this commodity: "Writers of the most learned works do not earn the wages of a day-labourer, whereas the writers of trashy and ephemeral novels may earn a fortune."

The practical remarks upon supply and demand and the folly of subsidising a trade so as to increase the supply where it is already too great for the demand (Vol. II. p. 213), and those upon the errors of the Socialists (p. 215), are good; and the old balance-of-trade error is fully exposed. But we do not see the mistake in the quotation from Mill (p. 76): a banker's credit would be small if he had not capital; and surely it is worse than a paradox to say that the policies of an Insurance Company are its capital; as well might the name be given to the money owing for raw material by a manufacturer!

In an attack upon writers of well-known ability, such as we have here, a critic should be careful of his own expressions. On p. 181, Vol. I., in lines 8 and 9 from the bottom, there is a reversal of the important words "debtor" and "creditor," which, though corrected in the next paragraph, adds to the puzzledom of

the whole passage. Again, on p. 200, even after carefully considering the meaning of "purchaser," "consumer," the author arrives at the conclusion that "the consumer is simply the purchaser or customer," whereas the consumer is the purchaser who does not intend to sell again. If an architect builds a palace (to take Mr. Macleod's first example) to carry out some grand idea of his own which he feels sure will attract him a royal customer for it, but lack of funds compels him to sell it unfinished to a commercial company who have a similar faith in his design, they are not consumers, because they intend to sell it again. But if a monarch retired from business buys it of them for his residence, he is the consumer, because, although the palace may stand for centuries, he does not intend to sell it again. To take a much more familiar case, going on under our own eyes: a builder erects a row of villas as a speculation of his own; as long as he has them on his hands they are stock in the market, but as one purchaser is found who elects to inhabit one, and another to inhabit another, those houses are, as far as economics is concerned, "consumed," and the builder is encouraged to produce more.

Far more careful printing is required in such a book. On p. 309, Vol. II., line 1 is quite unintelligible through the misplacing of two commas. On p. 156, no doubt the "division of labour" should be the "division of employment" with combination of labour. For the sake of clearness (we suppose) qualifications have been sacrificed in many places, with, we feel sure, mischievous effect to any student inquiring into the "elements" of so intricate a science.

OUR BOOK SHELF.

Outlines of Lectures on Physiology. By T. Wesley Mills. (Montreal: Drysdale and Co., 1886.)

THIS little work of scarcely 200 pages gives at a glance very precise information as to the kind of instruction provided in the Physiological Department of the McGill University.

The teaching appears to be both scientific and practical in its character, and of a standard certainly equal to that of the teaching in many of our English schools. Prof. Mills most properly insists on the importance of comparative physiology and biology, the only keys to many of the most complicated problems in human physiology itself. It is, however, unfortunate that he is obliged to incorporate so much elementary biology in his lectures, suggesting, as it does, that this important subject is, in Canada as well as in England, often relegated to the teachers of physiology, who should be in a position to begin with students already acquainted with the fundamental facts of this science. Pathology, or the application of physiology to disease, is hardly touched upon in this book. It is a most unfortunate omission, unless both pathology and therapeutics are taught in other departments of the University far more systematically than with us. From the fact that it is so sketchy it is difficult to understand how Dr. Mills' work can be of any value to the general reader who is not at the same time interested in the progress of medical education, or to the ordinary student of physiology. Under "Saliva" (page 86), which may be taken as an example, we find the following headings without any explanatory text. "Mixed saliva found in the mouth. Secretion of *serous* and mucous glands compared. Morphological elements of saliva. Chemical constitution," &c. The work professes, however, to be only an outline, and such it is.

Chemistry for Beginners. By R. L. Taylor. (London: Sampson Low and Co., 1887.)

THIS little book is valuable as being the outcome of practical experience in the teaching of the first principles of chemistry, and, from its small size and simple statement, is likely to be much used in the sphere for which it is intended. It appears eminently suited for the use of pupils in our higher grade Board schools, where the author has gained most of his experience, and may with advantage be used as an elementary class-book, especially as it contains a graduated series of original problems. We are glad to notice the introduction of an undoubtedly beneficial method of representing chemical reactions, which, especially in more complex cases, expresses what really happens in a very clear light. An example extracted from Mr. Taylor's book is as follows:—

$$\begin{array}{r|l} K & NO_3 \\ SO_4H & H. \end{array}$$

Of course, the equation written in the ordinary form is given, as is proper, side by side with the above.

Although it is unfortunate that the illustrations are of so primitive a character, the book is very readable and likely to interest beginners, and the author may be congratulated upon the absence of all appearance of cram, which has such a paralyzing influence upon the thinking powers of those from amongst whom our future chemists are to be derived. A. E. T.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Thought without Words.

THE recent work of Prof. Max Müller contains theories on the descent of man which are entirely based on the assertion that not even the most rudimentary processes of true thought can be carried on without words. From this he argues that as man is the only truly speaking animal the constitution of his mind is separated from that of brutes by a wide gulf, which no process of evolution that advanced by small steps could possibly stride over. Now, if a single instance can be substantiated of a man thinking without words, all this anthropological theory, which includes the more ambitious part of his work, will necessarily collapse.

I maintain that such instances exist, and the first that I shall mention, and which I will describe at length, is my own. Let me say that I am accustomed to introspection, and have practised it seriously, and that what I state now is not random talk but the result of frequent observation. It happens that I take pleasure in mechanical contrivances; the simpler of these are thought out by me absolutely without the use of any mental words. Suppose something does not fit; I examine it, go to my tools, pick out the right ones, and set to work and repair the defect, often without a single word crossing my mind. I can easily go through such a process in imagination, and inhibit any mental word from presenting itself. It is well known at billiards that some persons play much more "with their heads" than others. I am but an indifferent player; still, when I do play, I think out the best stroke as well as I can, but not in words. I hold the cue with nascent and anticipatory gesture, and follow the probable course of the ball from cushion to cushion with my eye before I make the stroke, but I say nothing whatever to myself. At chess, which I also play indifferently, I usually caculate my moves, but not more than one or two stages ahead, by eye alone.

Formerly I practised fencing, in which, as in billiards, the "head" counts for much. Though I do not fence now, I can mentally place myself in a fencing position, and then I am intent and mentally mute. I do not see how I could have used mental

words, because they take me as long to form as it does to speak or to hear them, and much longer than it takes to read them by eye (which I never do in imagination). There is no time in fencing for such a process. Again, I have many recollections of scrambles in wild places, one of which is still vivid, of crossing a broad torrent from stone to stone, over some of which the angry-looking water was washing. I was intellectually wearied when I got to the other side, from the constant care and intentness with which it had been necessary to exercise the judgment. During the crossing, I am sure, for similar reasons to those already given, that I was mentally mute. It may be objected that no true thought is exercised in the act of picking one's way, as a goat could do that, and much better than a man. I grant this as regards the goat, but deny the inference, because picking the way under difficult conditions does, I am convinced, greatly strain the attention and judgment. In simple algebra, I never use mental words. Latterly, for example, I had some common arithmetic series to sum, and worked them out, not by the use of the formula, but by the process through which the formula is calculated, and that without the necessity of any mental word. Let us suppose the question was, how many strokes were struck by a clock in twelve hours (not counting the half-hours), then I should have written 1, 2 . . . ; and below it, 12, 11, . . . ; then 2 . . . . 13×12, then $13 \times 6 = 78$. Addition, as De Morgan somewhere insisted, is far more swiftly done by the eye alone: the tendency to use mental words should be withstood. In simple geometry I always work with actual or mental lines; in fact, I fail to arrive at the full conviction that a problem is fairly taken in by me, unless I have contrived somehow to disembarrass it of words.

Prof. Max Müller says that no one can think of a dog without mentally using the word dog, or its equivalent in some other language, and he offers this as a crucial test of the truth of his theory. It utterly fails with me. On thinking of a dog, the name at once disappears, and I find myself mentally in that same expectant attitude in which I should be if I were told that a dog was in an obscure part of the room or just coming round the corner. I have no clear visual image of a dog, but the sense of an ill-defined spot that might shape itself into any specified form of dog, and that might jump, fawn, snarl, bark, or do anything else that a dog might do, but nothing else. I address myself in preparation for any act of the sort, just as when standing before an antagonist in fencing I am ready to meet any thrust or feint, but exclude from my anticipation every movement that falls without the province of fair fencing.

He gives another test of a more advanced mental process, namely, that of thinking of the phrase "cogito ergo sum" without words. I addressed myself to the task at a time when I was not in a mood for introspection, and was bungling over it when I insensibly lapsed into thinking, not for the first time, whether the statement was true. After a little, I surprised myself hard at thought in my usual way—that is, without a word passing through my mind. I was alternately placing myself mentally in the attitude of thinking, and then in that of being, and of watching how much was common to the two processes.

It is a serious drawback to me in writing, and still more in explaining myself, that I do not so easily think in words as otherwise. It often happens that after being hard at work, and having arrived at results that are perfectly clear and satisfactory to myself, when I try to express them in language I feel that I must begin by putting myself upon quite another intellectual plane. I have to translate my thoughts into a language that does not run very evenly with them. I therefore waste a vast deal of time in seeking for appropriate words and phrases, and am conscious, when required to speak on a sudden, of being often very obscure through mere verbal maladroitness, and not through want of clearness of perception. This is one of the small annoyances of my life. I may add that often while engaged in thinking out something I catch an accompaniment of nonsense words, just as the notes of a song might accompany thought. Also, that *after* I have made a mental step, the appropriate word frequently follows as an echo; as a rule, it does not accompany it.

Lastly, I frequently employ nonsense words as temporary symbols, as the logical x and y of ordinary thought, which is a practice that, as may well be conceived, does not conduce to clearness of exposition. So much for my own experiences, which I hold to be fatal to that claim of an invariable dependence between thoughts and words which Prof. Max Müller postulates as the ground of his anthropological theories.

As regards the habits of others, at the time when I was inquiring into the statistics of mental imagery, I obtained some answers to the following effect: "I depend so much upon mental pictures that I think if I were to lose the power of seeing them I should not be able to think at all." There is an admirable little book published last year or the year before by Binet, "Sur le Raisonnement," which is clear and solid, and deserves careful reading two or three times over. It contains pathological cases in which the very contingency of losing the power of seeing mental pictures just alluded to has taken place. The book shows the important part played by visual and motile as well as audile imaginations in the act of reasoning. This and much recent literature on the subject seems wholly unknown to Prof. Max Müller, who has fallen into the common error of writers not long since, but which I hoped had now become obsolete, of believing that the minds of everyone else are like one's own. His aptitudes and linguistic pursuits are likely to render him peculiarly dependent on words, and the other literary philosophers whom he quotes in partial confirmation of his extreme views are likely for the same cause, but in a less degree, to have been similarly dependent. Before a just knowledge can be attained concerning any faculty of the human race we must inquire into its distribution among all sorts and conditions of men, and on a large scale, and not among those persons alone who belong to a highly specialized literary class.

I have inquired myself so far as opportunities admitted, and arrived at a result that contradicts the fundamental proposition in the book before us, having ascertained, to my own satisfaction at least, that in a relatively small number of persons true thought is habitually carried on without the use of mental or spoken words.

FRANCIS GALTON.

Tabasheer mentioned in Older Botanical Works.

IN recent issues of NATURE (pp. 396 and 488) Mr. Thiselton Dyer and Mr. Judd have made two interesting contributions to the knowledge of "tabasheer," and Mr. Tokutaro Ito, and others, have supplied remarkable additional notes (pp. 462, 437, &c.). But no one has told us what is to be found about so interesting a substance in the older botanical works. In numerous botanical works of the præ-Linnean period, "tabaxir," as it was called by all authors of that time, is mentioned, and some of them give us very good information about it.

The first who wrote on tabasheer seems to have been Al-Hussain Abu-Ali Ebn Sina, or Avicenna, as he is generally called by Eastern literary men, a celebrated physician and minister of the Persian Empire, who lived from 980 till 1037, and whose works, written in Arabic, obtained as early as the twelfth century a very great reputation. Avicenna introduced the Persian word tabaxir, طباشير, into the Arabian language; it signifies "condensed milk-sap," or as Ray (Raius) translates it (1688) in his "Historia Plantarum," *lac lapidescens*. Avicenna was not well instructed about the origin of tabasheer, for in lib. ii. cap. 609, he says that it is got "ex radicibus arundinum crematis," and by these words he created an erroneous opinion, which lasted several centuries. For Gerardus of Cremona, who in the twelfth century translated the work of Avicenna into Latin, was induced by this suggestion to identify the Indian tabasheer with the *σποδός* of the Greeks or the Arabian "tutia," because this remedy was also got by burning the roots of a certain plant, which was probably a Lawsonia.[1]

This error was corrected by Garcia de Orta, the physician of a viceroy of India, who wrote a book "De Plantis et Aromatibus," in Portuguese, which was translated into Latin by De l'Ecluse (Clusius) in his "Exoticarum Libri Decem," and whose information is the best I have found in writers of that time. He says:—"Vocatur autem ab indigenis 'Sacar Mambu,' quasi dicas Saccharum de Mambu, quoniam Indi arundines, sive ramos arboris illud proferentes Mambu vocant. Attamen nunc etiam *Tabaxir* vocare coeperunt, quoniam eo nomine petitur ab Arabibus, Persis, et Turcis, qui id mercimonii causa ex India in suas regiones exportant. Magno emitur hoc medicamentum pro proventus eius ratione. *Eius tamen commune pretium in Arabia est, ut pari argenti pondere ematur.* Arbor in qua gignitur interdum magna est et instar Populi procera: Inter singula internodia liquor quidam dulcis generatur, crassus veluti

[1] Afterwards, the signification of the word "spodium," or "spodos," must have totally changed, for Matthiolius and others make it a mixture of metals, probably containing zinc.

amylum congestum et simili candore, interdum multus, nonnunquam vero perpaucus. Sed non omnes arundines sive rami eum humorem continent, at ii dumtaxat quos Bisnager, Batecala et pars Provinciae Malavar profert. Hic autem liquor concretus interdum nigricans et cinereus invenitur, sed non ideo improbatur. Nam aut ob nimiam humiditatem, aut quod diutius ligno inclusus permanserit, hunc sibi colorem conciliat: non autem ob arborum incendium, veluti nonnulli putarunt. Siquidem in multis ramis, quos non contigit ignis, niger etiam invenitur."

Garcia also gives information as to the medical virtues of tabasheer, which were esteemed to be very important at that time: "Ceterum ex Medicorum tum Indorum, tum Arabum, Persarum, et Turcorum testimonio Tabaxir internis et externis convenit ardoribus, tum etiam biliosis febribus et dysenteriis: praesertim autem in biliosis fluxionibus utuntur; nostri vero trochiscos ex eo conficiunt addito semine Oxalidis."

Almost all præ-Linnean writers who mentioned tabasheer for the most part only reproduced what they found in Garcia's book. Joh. Bauhinus even identifies the name of tabasheer with the plant itself, which he calls in his "Historia Plantarum," i. 2, p. 222, "Tabaxir sive Mambu arbor, Tabaxir folio oleae." Rumphius in his "Herbarium Amboinense," of the year 1763, relates that he had never found any trace of tabasheer in the bamboos growing in the Molucca Islands, except on one occasion:—"Juniores arundines plerumque in inferioribus suis nodis semi-repletae utcunque sunt lympida aqua potabili, quae hisce in terris sensim evanescit, in aliis vero regionibus exsiccatur in substantiam albam et calceam, quae Tabaxir vocatur. Illud tantum addere debeo, mihi in Hituae ora moranti semel adductum fuisse per pueros meos substantiam albam, siccamque instar farinae amyli, quae in illa ora ab illis fuerat detecta, quantum recordor, in Bulu seru (*Beesha humilis*, Kunth, *Bambusa Fax*, Poir.) fistulis, dura autem erat, sicca, ac penitus insipida omnibusque Aethiopibus, quibus ostendebam, ignota, ipsiusque albido sensim in cinereum degenerabat colorem."

Further information on tabasheer is given by Piso, a well-instructed Dutch physician, in the year 1658, but I am inclined to think that he is wrong in identifying "Achar," a sweet dish celebrated in India as well as in Europe at that time, with the tabaxir of the Eastern peoples. But let us hear what he says:—"Novissimi autem stolones, qui maxime succulenti sunt et saprosi magni fiunt in Indiis, apud Advenas aeque ac Indigenas, quod bases sunt celebris istius compositionis 'Achar' dictae, quae in Europam invecta in deliciis habetur palutum doctis, et a me quoque non semel cum voluptate gustata est. At vero ubi hae Arundines procerae et annosae factae fuerint, liquores contenti substantia, color, sapor, et efficacia mutantur, atque paullatim protruditur foras et iuxta internodium vi Solis coagulatur ac instar pumicis albi indurescit, mox nativae suavitatis expers facta, peculiarem saporem cum parva adstrictione, eboris usti aemulum acquirit, vocaturque apud indigenas 'Sacar Mambu'—Tabaxir Garciae et Acostae—qui quo levior, albicantior ac glabrior eo praestantior: quo magis inaequalis atque cinerei coloris evadit, deterior habetur."

Though it is very probable that under certain circumstances almost all species of the genus Bambusa and its allies are able to produce tabasheer, but few are specially mentioned as capable of producing this interesting substance. All the species that I have found noted in the literature of earlier and modern times are the following: (1) *Bambusa arundinacea*, Retz, or the common bamboo; (2) *Bambusa spinosa*, Roxb., which is called by Burmann, 1737, in his "Thesaurus Zeylanicus," "Arundo indica arborea maxima cortice spinosa Tabaxir fundens"; (3) *Beesha humilis*, Kunth, which is Rumph's bamboo mentioned above; (4) *Beesha Rheadii*, Kunth, and (5) *Guadua angustifolia*, Kunth, the species from which Humboldt's specimen of tabasheer was taken.

ERNST HUTH.

Frankfurt, Oder, April 17.

A Brilliant Meteor.

I SAW here this evening a splendid meteor; time, by London and North-Western Railway, 8.19. Its apparent point of origin was nearly south, and altitude 45° from the zenith; its path from east to west; finishing about west-south-west, some 30° from the horizon; duration at least four seconds. It increased in brilliancy until near extinction, when it quickly faded in a dull red glow, like that of the residuum from the fire-ball of a rocket. The head, of an apparent brilliancy three times that of a star of the first magnitude, had precisely the appearance of the incandescent spot of the oxy-hydrogen light, and the tail, very long, exhibited a red glow. Some neighbouring trees and the chimney of a house enabled me with a pocket compass to get the altitude and bearings approximately.

ARTHUR NICOLS.

Watford, May 8.

THE following particulars relating to a very fine meteor may be of service in fixing its course if it was seen elsewhere:—

(1) Position of observation: the open space in front of St. Anne's, Soho.

(2) Size: three or four times > Venus.

(3) Colour: decidedly green.

(4) Path: it was first seen somewhere near γ Geminorum, and in two or three seconds disappeared slowly behind the houses in the direction of Aldebaran.

(5) Time of disappearance: 20h. 22m. 19s. May 8.

The time can be relied upon, as my watch was compared on Saturday and again this morning with G.M.T.

Saturn was just visible, and Venus, therefore, must have been very bright, yet she seemed quite dull and yellow by the side of the splendid fireball.

MAURES HORNER.

28 Upper Montagu Street, W., May 9.

P.S.—γ Geminorum was of course invisible, and Aldebaran behind the houses.

ON Sunday, the 8th inst., at 8.23 p.m., a very brilliant meteor was seen here by a party of four persons, of whom I was one. When I first saw it, it was almost in the zenith, and appeared considerably larger and more luminous than Venus (which had been visible for some time), though of much the same colour. It crossed the sky in a north-westerly direction, and became invisible about 17° above the horizon. As it travelled, a brilliant trail of red light appeared behind it, which increased in length and brightness as it descended, being fully three times longer than the head, when it attained its greatest length.

The meteor was one of striking brilliance, and must have been specially so, as the sky which it crossed was still bright with the yellow glow of sunset.

ISABEL FRY.

5 The Grove, Highgate, May 10.

Residual Affinity.

I WAS greatly interested in Prof. Armstrong's recent articles on "Residual Affinity," as it is a subject I brought before the Royal Society of Edinburgh fully nine years ago, as one of the main causes of solution, molecular compounds, &c. I was, however, somewhat disappointed with the conclusions he came to, and was tempted to exclaim in Scriptural language, "Ye did run well; what did hinder you that you are again entangled in the yoke of *bondage*?" Prof. Armstrong comes to the conclusion that HCl and NH_3 combine owing to the residual affinity of Cl for N. Now how can this be? If we regard it from a thermal point of view, we find that, in the combination of HCl with NH_3, 41,900 units of heat are given out, while the combinations H with Cl and N with H_3 give out 22,000 and 11,890 units respectively; that is, the residual affinity of N for Cl, as measured by heat, exceeds by about one-third the sum of the affinities of H for Cl and H_3 for N; and yet, under ordinary circumstances, Cl has very little affinity for N. Is it not more rational to conclude that the residual affinity is not confined to the negative elements, but extends to both, and that the combination of HCl and NH_3 is due mainly to the residual affinity of Cl and N for H? It is easy to understand that this residual affinity is so lowered in intensity that neither Cl nor N can retain unassisted more than one and three atoms; but when the energy of the H is reduced by combination with another body, each of them can then act upon it. That residual affinity exists in both positive and negative elements seems to me evident from the fact that the heats of solution of salts in water vary directly as the affinity of the metal for the O of the water and also directly as the affinity of the negative element for the H, as I have pointed out in my letter on "Laws of Solution," in NATURE, vol. xxxiv. p. 263. It seems strange to me that chemists will search out for occult causes of phenomena which can much more easily be explained by what is already known of

the actions of one element on another rather than abandon the assumption that chemical affinity acts in definite units.

Portobello, April 28. WM. DURHAM.

[Without discussing the general question, I may point out that unfortunately we are at present unable to base any argument on the thermal behaviour of elements, as the fundamental values are entirely unknown: we do not know, for example, what amount of heat would be given out on combination of H and Cl; the value deduced for H_2,Cl_2 by Thomsen being the algebraic sum of several values, some of which are negative, some positive.—H. E. ARMSTRONG.]

The Spherical Integrator.

I FIND that my name has been alluded to in a letter by Prof. Hele Shaw, in your last number (vol. xxxv. p. 581).

I shall be glad if you will kindly permit me to state that the idea of reducing the moment of inertia of the sphere in a spherical integrator, by making it hollow, occurred to me while abroad in Algeria. An account of the modified form is given in the *Phil. Mag.*, August 1886, p. 147. I now find, from a letter from Prof. Shaw, of this month, that exactly the same method of dealing with the difficulty had occurred to him. At the end of Prof. Shaw's letter in your last issue the following words are used: "Now in the 'sine' form, of which this integrator is an example, this pin should move in the arc of a circle, and it would be interesting to know if approximately correct results have been obtained with what is in some respects a more convenient device." From this it would appear that the principle of the instrument is not correct. This morning I received a post-card from Prof. Shaw in which he writes that he had misunderstood the diagrammatic outline in the *Phil. Mag.* His words are: "You are quite right as you use it; I was thinking of a contrivance in which the sphere and frame move together." With respect to M. Ventosa's letter on the subject, in your paper of a month ago, (p. 513) in which he speaks very favourably of the method of using a hollow sphere, although M. Ventosa used a spherical integrator in a certain form of anemometer at an early date, yet I think that all who have seen and read Prof. Shaw's work will admit that he has expanded the use of the spherical integrator and its mathematical importance in a way which is both masterly and original. FREDK. SMITH.

28 Norham Gardens, Oxford, April 25.

THE HENRY DRAPER MEMORIAL.[1]

DR. HENRY DRAPER, in 1872, was the first to photograph the lines of a stellar spectrum. His investigation, pursued for many years with great skill and ingenuity, was most unfortunately interrupted in 1882 by his death. The recent advances in dry-plate photography have vastly increased our powers of dealing with this subject. Early in 1886, accordingly, Mrs. Draper made a liberal provision for carrying on this investigation at the Harvard College Observatory, as a memorial to her husband. The results attained are described below, and show that an opportunity is open for a very important and extensive investigation in this branch of astronomical physics. Mrs. Draper has accordingly decided greatly to extend the original plan of work, and to have it conducted on a scale suited to its importance. The attempt will be made to include all portions of the subject, so that the final results shall form a complete discussion of the constitution and conditions of the stars, as revealed by their spectra, so far as present scientific methods permit. It is hoped that a greater advance will thus be made than if the subject was divided among several institutions, or than if a broader range of astronomical study was attempted. It is expected that a station to be established in the southern hemisphere will permit the work to be extended so that a similar method of study may be applied to stars in all parts of the sky. The investigations already undertaken, and described below more in detail, include a catalogue of the spectra of all stars north of $-24°$ of the sixth magnitude and brighter, a more extensive catalogue of spectra of stars brighter than the eighth magnitude, and a detailed study of the spectra of the bright stars. This last will include a classification of the spectra, a determination of the wave-lengths of the lines, a comparison with terrestrial spectra, and an application of the results to the measurement of the approach and recession of the stars. A special photographic investigation will also be undertaken of the spectra of the banded stars, and of the ends of the spectra of the bright stars. The instruments employed are an 8-inch Voigtländer photographic lens re-ground by Alvan Clark and Sons, and Dr. Draper's 11-inch photographic lens, for which Mrs. Draper has provided a new mounting and observatory. The 15-inch refractor belonging to the Harvard College Observatory has also been employed in various experiments with a slit spectroscope, and is again being used as described below. Mrs. Draper has decided to send to Cambridge a 28-inch reflector and its mounting, and a 15-inch mirror, which is one of the most perfect reflectors constructed by Dr. Draper, and with which his photograph of the moon was taken. The first two instruments mentioned above have been kept at work during the first part of every clear night for several months. It is now intended that at least three telescopes shall be used during the whole night, until the work is interrupted by daylight.

The spectra have been produced by placing in front of the telescope a large prism, thus returning to the method originally employed by Fraunhofer in the first study of stellar spectra. Four 15° prisms have been constructed, the three largest having clear apertures of nearly 11 inches, and the fourth being somewhat smaller. The entire weight of these prisms exceeds a hundred pounds, and they fill a brass cubical box a foot on each side. The spectrum of a star formed by this apparatus is extremely narrow when the telescope is driven by clockwork in the usual way. A motion is accordingly given to the telescope slightly differing from that of the earth by means of a secondary clock controlling it electrically. The spectrum is thus spread into a band, having a width proportional to the time of exposure and to the rate of the controlling clock.

This band is generally not uniformly dense. It exhibits lines perpendicular to the refracting edge of the prism, such as are produced in the field of an ordinary spectroscope by particles of dust upon the slit. In the present case, these lines may be due to variations in the transparency of the air during the time of exposure, or to instrumental causes, such as irregular running of the driving clock, or slight changes in the motion of the telescope, resulting from the manner in which its polar axis is supported. These instrumental defects may be too small to be detected in ordinary micrometric or photographic observations, and still sufficient to affect the photographs just described.

A method of enlargement has been tried which gives very satisfactory results, and removes the lines above mentioned as defects in the negatives. A cylindrical lens is placed close to the enlarging lens, with its axis parallel to the length of the spectrum. In the apparatus actually employed, the length of the spectrum, and with it the dispersion, is increased five times, while the breadth is made in all cases about 4 inches. The advantage of this arrangement is, that it greatly reduces the difficulty arising from the feeble light of the star. Until very lately, the spectra in the original negatives were made very narrow, since otherwise the intensity of the starlight would have been insufficient to produce the proper decomposition of the silver particles. The enlargement being made by daylight, the vast amount of energy then available is controlled by the original negative, the action

[1] "First Annual Report of the Photographic Study of Stellar Spectra." Conducted at the Harvard College Observatory." Edward C. Pickering, Director. With Plate. (Cambridge: John Wilson and Son, University Press, 1887.)

of which may be compared to that of a telegraphic relay. The copies therefore represent many hundred times the original energy received from the stars. If care is not taken, the dust and irregularities of the film will give trouble, each foreign particle appearing as a fine spectral line.

Other methods of enlargement have been considered, and some of them tried, with the object of removing the irregularities of the original spectra without introducing new defects. For instance, the sensitive plate may be moved during the enlargement in the direction of the spectral lines; a slit parallel to the lines may be used as the source of light, and the original negative separated by a small interval from the plate used for the copy; or two cylindrical lenses may be used, with their axes perpendicular to each other. In some of these ways the lines due to dust might either be avoided or so much reduced in length as not to resemble the true lines of the spectrum.

The 15-inch refractor is now being used with a modification of the apparatus employed by Dr. Draper in his first experiments,—a slit spectroscope from which the slit has been removed. A concave lens has been substituted for the collimator and slit, and, besides other advantages, a great saving in length is secured by this change. It is proposed to apply this method to the 28-inch reflector thus utilising its great power of gathering light. . . . .

The results to be derived from the large number of photographs already obtained can only be stated after a long series of measurements and a careful reduction and discussion of them. An inspection of the plates, however, shows some points of interest. A photograph of α Cygni, taken November 26, 1886, shows that the H line is double, its two components having a difference in wave-length of about one ten-millionth of a millimetre. A photograph of ο Ceti shows that the lines G and *h* are bright, as are also four of the ultraviolet lines characteristic of spectra of the first type. The H and K lines in this spectrum are dark, showing that they probably do not belong to that series of lines. The star near χ^1 Orionis, discovered by Gore in December 1885, gives a similar spectrum, which affords additional evidence that it is a variable of the same class as ο Ceti. Spectra of Sirius show a large number of faint lines besides the well-known broad lines.

The dispersion employed in any normal map of the spectrum may be expressed by its scale, that is, by the ratio of the wave-length as represented to the actual wave-length. It will be more convenient to divide these ratios by one million, to avoid the large numbers otherwise involved. If one-millionth of a millimetre is taken as the unit of wave-length, the length of this unit on the map in millimetres will give the same measure of the dispersion as that just described. When the map is not normal, the dispersion of course varies in different parts. It increases rapidly towards the violet end when the spectrum is formed by a prism. Accordingly, in this case the dispersion given will be that of the point whose wave-length is 400. This point lies near the middle of the photographic spectrum when a prism is used, and is not far from the H line. The dispersion may accordingly be found with sufficient accuracy by measuring the interval between the H and K lines, and dividing the result in millimetres by 3·4, since the difference in their wave-lengths equals this quantity. The following examples serve to illustrate the dispersion expressed in this way: Angström, Cornu, 10; Draper, photograph of normal solar spectrum, 3·1 and 5·2; Rowland, 23, 33, and 46; Draper, stellar spectra, 0·16; Huggins, 0·1. Fig. 1, 0·06; Fig. 2, 0·10; Fig. 3, 0·63; Fig. 4, 1·3; Figs. 5 and 6, 6·5.

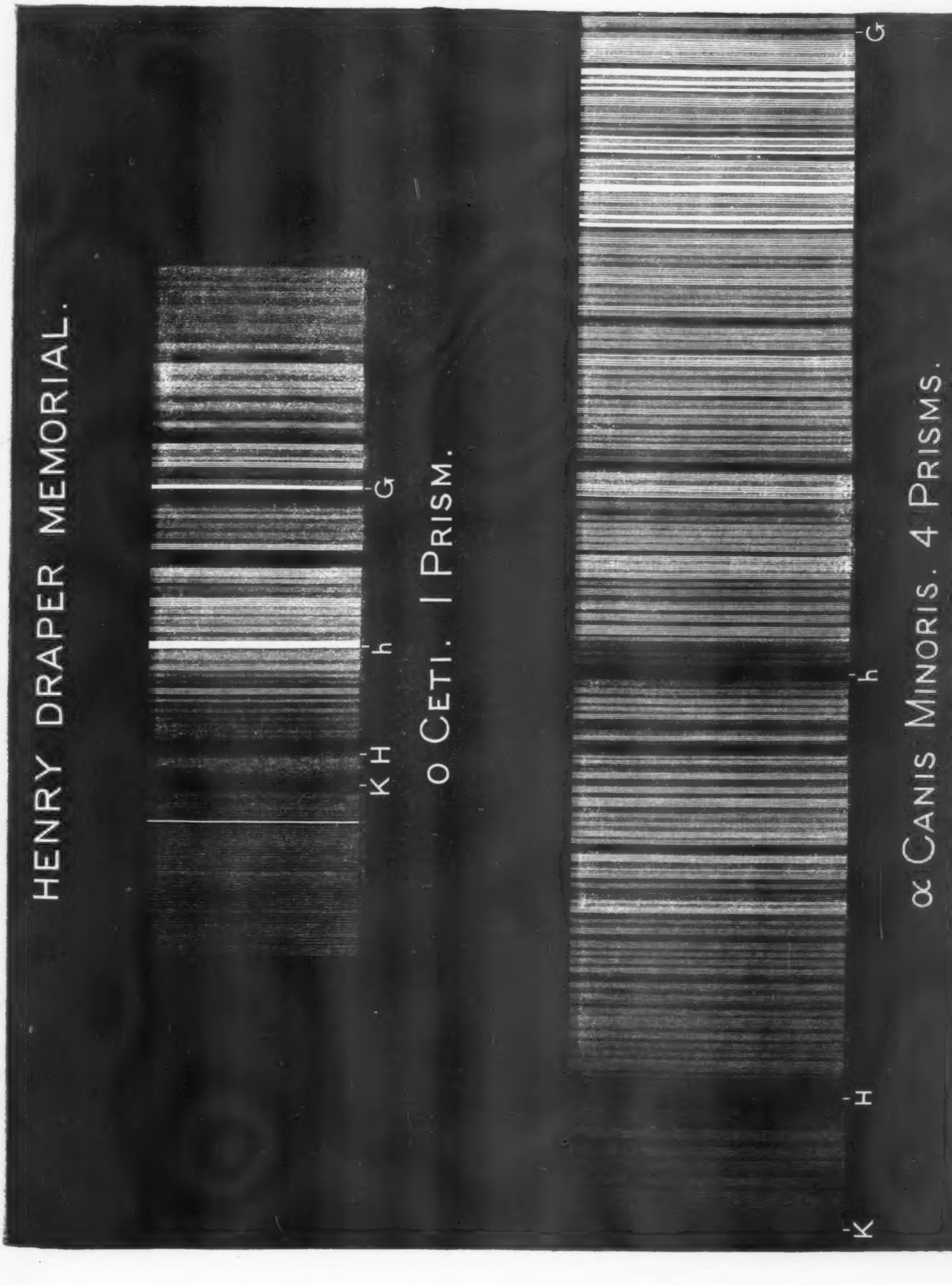
The most rapid plates are needed in this work, other considerations being generally of less importance. Accordingly the Allen and Rowell Extra Quick plates have been used until recently. It was found, however, that they were surpassed by the Seed Plates No. 21, which were accordingly substituted for them early in December. Recognising the importance of supplying this demand for the most sensitive plates possible, the Seed Company have recently succeeded in making still more sensitive plates, which we are now using. The limit does not seem to be reached even yet. Plates could easily be handled if the sensitiveness were increased tenfold. A vast increase in the results may be anticipated with each improvement of the plates in this respect. Apparatus for testing plates, which is believed to be much more accurate than that ordinarily employed, is in course of preparation. It is expected that a very precise determination will be made of the rapidity of the plates employed. Makers of very rapid plates are invited to send specimens for trial.

The photographic work has been done by Mr. W. P. Gerrish, who has also rendered important assistance in other parts of the investigation. He has shown great skill in various experiments which have been tried, and in the use of various novel and delicate instruments. Many of the experimental difficulties could not have been overcome but for the untiring skill and perseverance of Mr. George B. Clark, of the firm of Alvan Clark and Sons, by whom all the large instruments have been constructed.

The progress of the various investigations which are to form a part of this work is given below:—

(1) *Catalogue of Spectra of Bright Stars.*—This is a continuation of the work undertaken with the aid of an appropriation from the Bache Fund, and described in the Memoirs of the American Academy, vol. xi. p. 210. The 8-inch telescope is used, each photograph covering a region 10° square. The exposures for equatorial stars last for five minutes, and the rate of the clock is such that the spectra have a width of about 0·1 cm. The length of the spectra is about 1·2 cm. for the brighter, and 0·6 cm. for the fainter stars. The dispersion on the scale proposed above is 0·1. The spectra of all stars of the sixth magnitude and brighter will generally be found upon these plates, except in the case of red stars. Many fainter blue stars also appear. Three or four exposures are made upon a single plate. The entire sky north of −24° would be covered twice, according to this plan, with 180 plates and 690 exposures. It is found preferable in some cases to make only two exposures; and when the plate appears to be a poor one, the work is repeated. The number of plates is therefore increased. Last summer the plates appeared to be giving poor results. Dust on the prisms seemed to be the explanation of this difficulty. Many regions were re-observed on this account. The first cycle, covering the entire sky from zero to twenty-four hours of right ascension, has been completed. The work will be finished during the coming year by a second cycle of observations, which has already been begun. The first cycle contains 257 plates, all of which have been measured, and a large part of the reduction completed. 8313 spectra have been measured on them, nearly all of which have been identified, and the places of a greater portion of the stars brought forward to the year 1900, and entered in catalogue form. In the second cycle, 64 plates have been taken, and about as many more will be required. 51 plates have been measured and identified, including 2974 spectra. A study of the photographic brightness and distribution of the light in the spectra will also be made.

The results will be published in the form of a catalogue resembling the Photometric Catalogue given in vol. xiv. of the Annals of Harvard College Observatory. It will contain the approximate place of each star for 1900, its designation, the character of the spectrum as derived from each of the plates in which it was photographed,


HENRY DRAPER MEMORIAL.
o CETI. 1 PRISM.
α CANIS MINORIS. 4 PRISMS.
G
h
H
K

the references to these plates, and the photographic brightness of the star.

(2) *Catalogue of Spectra of Faint Stars.*—This work resembles the preceding, but is much more extensive. The same instrument is used, but each region has an exposure of an hour, the rate of the clock being such that the width of the spectrum will be as before 0·1 cm. Many stars of the ninth magnitude will thus be included, and nearly all brighter than the eighth. In one case, over three hundred spectra are shown on a single plate. This work has been carried on only in the intervals when the telescope was not needed for other purposes. 99 plates have however been obtained, and on these 4442 spectra have been measured. It is proposed to complete the equatorial zones first, gradually extending the work northward. In all, 15,729 spectra of bright and faint stars have been measured.

(3) *Detailed Study of the Spectra of the Brighter Stars.*—This work has been carried on with the 11-inch photographic telescope used by Dr. Draper in his later researches. A wooden observatory was constructed about 20 feet square. This was surmounted by a dome having a clear diameter of 18 feet on the inside. The dome had a wooden frame, sheathed and covered with canvas. It rested on eight cast-iron wheels, and was easily moved by hand, the power being directly applied. Work was begun upon it in June, and the first observations were made with the telescope in October. Two prisms were formed by splitting a thick plate of glass diagonally. These gave such good results that two others were made in the same way, and the entire battery of four prisms is ordinarily used. The safety and convenience of handling the prisms is greatly increased by placing them in square brass boxes, each of which slides into place like a drawer. Any combination of the prisms may thus be employed. As is usual in such an investigation, a great variety of difficulties have been encountered, and the most important of them have now been overcome.

(4) *Faint Stellar Spectra.*—The 28-inch reflector will be used for the study of the spectra of the faint stars, and also for the fainter portions near the ends of the spectra of the brighter stars. The form of spectroscope mentioned above, in which the collimator and slit are replaced by a concave lens, will be tried. The objects to be examined are, first, the stars known to be variable, with the expectation that some evidence may be afforded of the cause of the variation. The stars whose spectrum is known to be banded, to contain bright lines, or to be peculiar in other respects, will also be examined systematically. Experiments will also be tried with orthochromatic plates and the use of a coloured absorbing medium, in order to photograph the red portions of the spectra of the bright stars. Quartz will also be tried to extend the images towards the ultra-violet.

(5) *Absorption Spectra.*—The ordinary form of comparison spectrum cannot be employed on account of the absence of a slit. The most promising method of determining the wave-lengths of the stellar spectra is to interpose some absorbent medium. Experiments are in progress with hyponitric fumes and other substances. A tank containing one of these materials is interposed, and the spectra photographed through it. The stellar spectra will then be traversed by lines resulting from the absorption of the media thus interposed, and, after their wave-lengths are once determined, they serve as a precise standard to which the stellar lines may be referred. The absorption-lines of the terrestrial atmosphere would form the best standard for this purpose if those which are sufficiently fine can be photographed.

(6) *Wave-Lengths.*—The determination of the wave-lengths of the lines in the stellar spectra will form an important part of the work which has not yet been begun. The approximate wave-lengths can readily be found from a comparison with the solar spectrum, a sufficient number of solar lines being present in most stellar spectra. As a difference of one ten-millionth of a millimetre in wave-length exceeds half a millimetre in Figs. 5 and 6 of the accompanying plate, the readings may be made with considerable accuracy by a simple inspection. For greater precision special precautions are necessary on account of the deviation caused by the approach and recession of the stars. The deviation found by Dr. Huggins in the case of Sirius would correspond to a change in the position of the lines of Figs. 5 and 6 of about half a millimetre. If, then, satisfactory results are obtained in the preceding investigation, the motion of the stars can probably be determined with a high degree of precision. The identification of the lines with those of terrestrial substances will of course form a part of the work, but the details will be considered subsequently.

From the above statement it will be seen that photographic apparatus has been furnished on a scale unequalled elsewhere. But what is more important, Mrs. Draper has not only provided the means for keeping these instruments actively employed, several of them during the whole of every clear night, but also of reducing the results by a considerable force of computers, and of publishing them in a suitable form. A field of work of great extent and promise is open, and there seems to be an opportunity to erect to the name of Dr. Henry Draper a memorial such as heretofore no astronomer has received. One cannot but hope that such an example may be imitated in other departments of astronomy, and that hereafter other names may be commemorated, not by a needless duplication of unsupported observatories, but by the more lasting monuments of useful work accomplished.

EDWARD C. PICKERING,
Director of Harvard College Observatory.
Cambridge, Mass., U.S.A., March 1, 1887.

SCIENCE AND GUNNERY.

I.

IN the last lecture which Prof. Tyndall delivered at the Royal Institution, he expressed a doubt as to whether extensive reading and study had not a tendency to hamper original genius, whether doctrines handed down for generations as articles of faith, which it would be heresy to dispute, had not materially checked the progress of science. Had he wished to illustrate his theory, he could not have had better examples than are to be found in the administration of our naval and military systems. It has been a reproach to us, as by far the greatest maritime nation of the world, that we have no School of Shipbuilding, that, until quite recently, naval officers have had no instruction except such as they could get in the practical execution of their duties, and no method existed of testing their knowledge except such rough-and-ready examinations as their superior officers could administer. Yet under these seeming disadvantages the Navy and the merchant service have kept in the forefront of progress, and have adopted all the newest discoveries of science, or of practical skill, as fast as they have been brought to light.

On the other hand, the officers of Artillery and Engineers have long been considered as belonging to the scientific branches of the service; they have been regularly trained in schools in which theory and history have been taught, and the consequence seems to be that it is most difficult to make the departments with which they are connected move with the times. How else can it be explained that we have adhered to wrought iron as a material for guns, and to muzzle-loaders, long after nations esteemed semi-barbarous have used steel and constructed breech-loaders? or how can we explain the waste of millions in constructing fortifications of patterns long obsolete, and which show no more originality than that exhibited in using

in some places iron instead of stone to resist the greater energy of modern projectiles? Not but that there have been many men both in the Artillery and Engineers who have seen the unfitness of what we have been doing, and have energetically protested against it, but they have not had force enough at the War Office to overcome the inertia due to the complacency derived from, perhaps, just pride in a profound knowledge of books.

We do not go quite the length of Dr. Tyndall's opinions, though we admit that there is much truth in them; we recognise the difficulty of teaching in advance, if we may use the expression; but there can be no doubt that precedent and routine have much to answer for, and account for the reluctance of Professors to admit that many of the old methods of fortification and artillery are as dead and useless as the matchlock or the old castle. Besides these considerations derived from experience of the services, we have the fact that most of the original inventions in the construction of guns and carriages have been the work of civil engineers and mechanics, who have been unhampered by precedent and unchecked by authority, and this circumstance must be our apology, as a non-professional paper, for devoting some space to a discussion of the present state of the science of fortification, especially with regard to our own coast defences.

It cannot be disputed, in the first place, that the projectiles delivered by modern guns are distinguished by greatly extended range, by much greater accuracy of flight, by immensely greater weight and destructive power, and by increased rapidity and precision of firing; but on the other hand it must also be admitted that in fighting at long ranges there will be greater waste of ammunition, and that, to put it plainly, excitement and fright go far to neutralise the advantages gained by our improved weapons, and that, consequently, defensive works should be planned so as to give the utmost possible security and sense of safety to the garrison. It is only necessary to study the records of recent naval actions, such as those during the War of Secession in the United States, the bombardment of Alexandria, or fights with dense hordes of savages in the Soudan and elsewhere, to be satisfied of the fact that the amount of destruction caused is small compared with the terrific fire employed. In the case of attack by artillery on shore the results are not so unsatisfactory, the steadiness of the platform, the accurately known range, the immovability of the gun and object fired at, the fact that the best and steadiest soldiers can be selected to aim, and that any nervousness in the gunner does not unsteady the gun, makes the fire of field and siege artillery approach much more nearly to what can be attained in times of peace; but even then, as in the Navy, smartness and rapidity of fire, the descendants of time-honoured drill, aggravated by excitement, are often the cause of a lamentable sacrifice of accuracy.

To make good shooting it is imperative that the men should be reasonably safe, especially against wholesale slaughter such as is caused by the bursting of a shell in a casemate, and this necessity is all the more imperative at the beginning of a war, when most of the soldiers have as yet never heard the shriek of a shell at their ears, or witnessed its terrifying effects. The shooting should be slow and deliberate in order to be effective, the result of each shot should be ascertained, for it must be remembered that the costly charges now fired are no more effective than those of the old smooth-bore artillery unless they reach their destination.

Next, the advantage of long range, accuracy, and rapidity of fire is in a great degree neutralised by the dense volumes of smoke produced by the modern large charges of powder, and although smoke may prove a valuable protection against the accuracy of an enemy's fire, it undoubtedly limits one's own offensive power except under certain conditions to which we will refer again.

In the last place, it may be conceded that an object which you cannot see you cannot aim at; that to be invisible is better than to be protected by armour, and this desirable condition of safety is easily attained in the case of coast defences against ships, because a ship, being always more or less in motion, even when at anchor, can never mark accurately any object of which it can get only an occasional peep. Thus, at the bombardment of Alexandria, one of the undoubted advantages on the side of the defenders was that some of their batteries were not to be distinguished from the irregular features of the rocky coast, and their presence could only be detected by the puffs of smoke from their guns. Even the old-established rules relating to fortifications admit the necessity of concealment; the greatest secrecy is maintained as to the internal economy of forts; access to them cannot be obtained without great difficulty, although we believe that little or nothing is to be gained by such precautions. What should be concealed is the fort itself, and its construction should be of such a nature that the fire of an enemy could not reach the essential mountings and stores it is intended to protect. Even Nature teaches us a lesson in this respect: animals liable to be the prey of others construct their nests of a form and colour and dispose of them so as to be invisible from a short distance, and even the colour of their plumage or their fur is made to assimilate to the tints which surround them; and the tactics they employ when in danger are to lie still so as not to attract attention.

The propositions which we have laid down, and which we do not imagine can be disputed, are of a nature to condemn at once the old systems of fortification, which appear to us to be specially contrived to afford the peculiar advantages which an enemy would desire; nor are alternative and more rational methods wanting, for as far back as May 7, 1869, at the Royal Institution of Great Britain, a paper, describing a new system of coast fortification calculated to meet the changes in artillery and the modern conditions of naval attack, was read by Colonel Moncrieff. In that paper the principle of concealment was laid down, the manner of carrying out the system explained, and the first workable disappearing gun-carriage, which made the realisation of the principles enunciated practicable, was described.

The time for bringing the matter before the public was also opportune, because the loan which had been contracted for strengthening the defences of the country had not all been expended, while the advance in the range and power of artillery was beginning to be fully realised. The authorities, however, were blind to the principles involved; they accepted, indeed, the disappearing gun, but they rejected the system of which it was only a detail. It would have been better had they accepted the system, and rejected the gun-carriage. The consequence of this incredible want of common-sense and discernment has been that a series of misapplications of the methods advocated by Colonel Moncrieff have been perpetrated by the War Office, as, for example, at Milford Haven, Hubberston, Newhaven, Popston, &c. In some of these forts the emplacements for the disappearing guns are actually formed on the top of casemates, crowded into the most conspicuous positions possible.

Those who have had an opportunity of witnessing the trials of guns and their carriages at the Royal Arsenal, must have been struck with the marvellous resistance which a heap of earth opposes to the proof shots fired into it. An insignificant mound stops the heaviest projectiles fired at a few yards' range from the most powerful guns loaded with proof charges, the mound remains uninjured, though daily subjected to blows which would soon wreck any structure made of the most solid materials. The Moncrieff system is specially adapted to take advantage of this stubborn resistance of earth, and that circumstance alone should have commended it to the official mind long years ago, especially as, in addition, the necessarily slight

inclination of the slopes affords the farther protection derived from the shot glancing off them.

But even the partial recognition of the principle of concealment, the principle of opposing a bank of earth rather than walls of masonry or iron to the tremendous missiles of the present day, flickered and died out; and the War Office, returning to its evil ways, has, within the last few years, erected at enormous cost batteries made as conspicuous as possible, often more than one story high, and has sought to keep out the fire, which these arrangements are calculated to draw, by clothing the batteries with more iron armour, or protecting the embrasures with stronger iron shields; while to make the work of the enemy more easy, and our defence more difficult, the guns have been massed together in the orthodox style, so that but a portion of them are ever likely to come into action, while the men in the whole battery will be "demoralised"—this, we believe, is the technical expression—by a shell bursting in any one of the convenient funnel-shaped openings considerately presented for their reception.

The smoke, likewise, of so many guns is certain to prove most prejudicial to good shooting, and within the forts themselves are generally placed the barracks, which must necessarily soon be reduced to ruin, either by direct or by curved fire, and thus increase the confusion and loss of life in action. No human being, it seems to us, can with impunity stand the constant strain of such conditions on the nervous system. When off work, the garrison of a fort should be safe, their lodging should be secure, their meals should be eaten in peace and security, and the sick and wounded should not be harassed by noise and turmoil. For these reasons the barracks should be at a distance from the battery, and should be hid away out of the enemy's sight, and connected with the battery by covered or screened ways.

In elevated positions, such as are occupied by some of the forts in the Isle of Wight, the natural features of the ground should have been taken advantage of, so as to render them invisible, the guns mounted in open barbette should be painted such a colour as to render them inconspicuous, instead of the uniform black now adopted, and Nature should be allowed to obliterate as much as possible, by the growth of brushwood and grass, the changes which the Engineers may have been compelled to make in the contour of the country. The Inspecting-General and the public generally, would, no doubt, not be able to gaze with delight on the trim slopes, the regular lines, and the frowning cannon, but ample compensation for this will be found in the circumstance that, in time of need, the enemy would be equally at fault.

Again, in coast defences near to the water, the guns, instead of being concentrated, should be dispersed, each gun should have a wide lateral range, the guns should retire out of sight and of exposure, except for the few moments required to lay and fire them. The emplacements should be connected with each other and with the barracks by screened roads, and bomb-proof rooms should be provided for the use of the men on duty when not required to work the guns. The screened roads, having parapets towards the sea, and towards the land also if necessary, would serve the triple purpose of intrenchments, interior lines of communication, and emplacements for light artillery to repel landings.

It may be urged that such work would prove costly on account of the large area of land required, but that would not be the case. The strips of land for roads or military tramways, and the small plots for emplacements, would be as cheaply obtained as for a railway, and by virtue of similar powers; in most places the cost of land would not be greater than that of armoured structures, the slopes and glacis would be just as available after as before for cultivation, and need not even be purchased, while, if definite plans could at once be adopted for our extensive coasts, a most useful class of work would be available in bad times, such as now press upon us, for the unemployed, and the relief would be widely felt because works are needed all over the kingdom.

The recent experiments at Portland have proved beyond all question that it is next to impossible for a ship at even so small a range as 800 yards, to hit a gun appearing out of a pit for three minutes, when the pit is so arranged, as it is the essential feature of the Moncrieff system that it should be, that its position cannot be detected from the sea. But three minutes is at least six times as long an exposure as is necessary; indeed, the art of determining the exact position of ships approaching coast batteries has been brought to such perfection that the officer in command of each gun would receive from the observing station messages as to the exact position of the enemy, the training and elevation to be given to the gun, the proper moment for raising it into action, and even, by means of electric fuses, the guns may be fired by the observing officer without risk to a single man, and with an exposure of the guns of less duration than the time required for the flight of a projectile at long range. Contrast such arrangements as these with the open barbette battery at Inchkeith, constructed as if on purpose to offer a conspicuous target, and which recent experiments have proved to be correspondingly vulnerable; or with the quite recently constructed turret, mounting a 10-inch gun at Eastbourne, where the projectile of a machine-gun disabled the 27-ton cannon, and one shot from a 6-inch breech-loader knocked off several feet of its barrel.

A careful study of the numerous papers on coast defence read before the United Service Institution, and the discussions, in which many eminent officers of all branches of the service took part, convinces us of the correctness of the views we are maintaining, and the need which exists for laying down organised plans of defence not only for places already protected, but for our long, and in many cases easily accessible, coast-lines. The smoke, which all the speakers agreed in recognising as a great evil in concentrated batteries, would scarcely be any impediment when the guns are scattered, partly because, under most circumstances, the smoke would blow away from each emplacement without obscuring its own gun, or the others, and partly because the observing officer would be above the smoke, and could always make out the enemy.

The smoke itself offers a very feeble indication of the precise locality of the gun which produced it, partly because it is projected a good way from the emplacement at once, partly because the wind in most cases will blow it away to one side or the other. This was fully proved at Portland, when the puffs of smoke sent up as the gun disappeared proved of no assistance to the attack.

But it may be urged, by those unacquainted with the subject, that so formidable a work as raising a heavy gun into the firing position, and checking its recoil and its fall at the same time, would involve cumbersome machinery and the employment of steam or other power. The answer is, that the energy of the discharge itself has been utilised to do all that is required.

The public has been much interested of late in the beautiful mechanism by means of which Mr. Maxim has utilised the energy of recoil, not only to run out the barrel of his gun at every shot, but also to perform all the operations of loading and firing automatically, and that at a rate which almost baffles the imagination. Six hundred shots per minute can be fired without any external power being used. The energy imparted to the shot must have its counterpart in the movement of the gun and carriage in the opposite direction; and Colonel Moncrieff, twenty years ago, showed how, by suitable mechanical arrangements, guns of all sizes could be made to recoil under cover and be raised again into the firing position without the application of external force. There are two systems by which this is accomplished, by means of counter-

weights and by means of metallic or air springs. In the former case it is easy to see how the counterweight can be so arranged that the work represented by the falling of the gun may be exactly balanced by the work of lifting the balance weight; the energy of recoil, therefore, need only be drawn upon to overcome the friction of the descent and the subsequent friction of ascent, together with the accelerating force necessary to start the gun into smart upward movement. The total amount of work expended in friction does not probably exceed 20 per cent. of the work of raising the gun, and consequently the old muzzle-loaders, with their comparatively small charges and low muzzle velocities of projectile, yield ample power to allow the guns to be lowered completely beyond the reach of hostile shot.

This is a consideration of great importance, because year by year a large number of excellent muzzle-loading guns of all calibres will be returned into store from the Navy, and may at once be utilised for strengthening our coast defences, for they are quite powerful enough to act against unarmoured vessels, light-draught transports, and such like, as well as against the unprotected parts of ironclads; while as howitzers they would be invaluable for preventing landing from boats, and for this service would be quite as effective as the longer, more costly, and more delicately-made breech-loaders, which, however, should be associated with them to resist ironclads. It so happens, also, that the short muzzle-loader is particularly well suited to the Moncrieff carriage, because the men engaged in loading, training, and elevating, working completely under the parapet, are in absolute safety from the enemy's fire, and the only man exposed is he who lays the gun, and even that exposure, as we have already remarked, can often be dispensed with. The muzzle-loaders are also much more simple weapons to manage than the modern, more powerful guns, and would therefore be better fitted for coast batteries, which would undoubtedly have to be manned and worked by Volunteers and men not so highly trained as the Artillery of the regular army.

Some years ago, the War Office definitely adopted the Moncrieff counterweight carriage, and mounted, successfully, guns as large as the 9-inch of 12 tons weight; but after a time evil counsels prevailed, inveterate prejudice triumphed, and the nation has been saddled with a vast expenditure on forts, which are already obsolete, for by no sort of ingenuity can they be made to carry artillery fitted to cope with that which will be opposed to them. Not that the system was ever rightly applied: Colonel Moncrieff, though attached to the War Department for the express purpose of developing his views, does not appear to have been consulted as to the arrangement of his batteries, or, if consulted, his views were ignored, and the consequence is that, in the case of the comparatively few guns which have been mounted, most of the emplacements are made as conspicuous as possible, and in that way the inestimable advantages of concealment have been thrown away.

The counterweight system, however, becomes very cumbersome when guns exceed some 20 tons in weight. Recourse can then be had to compressed air as a means of storing the energy of recoil. But the work done in compressing air reveals itself in the form of heat, which raises its temperature, and is slowly dissipated as it cools. Again, the air, in expanding to raise the gun, is cooled by the amount of heat converted into work, and its pressure is thereby reduced, so that the losses on these two accounts, added to the somewhat increased friction of the machinery, set a limit to the height to which the stored energy of recoil can raise the gun: the increased charges used in modern artillery, however, compensate for these losses, and it is possible by hydro-pneumatic arrangement to give efficient cover to the heaviest guns. The natural fear arises lest the introduction of water and compressed air may not add elements of danger in the facility with which dirt and debris, not sufficient to injure an ordinary mounting, may affect the more complicated arrangement. There is no doubt that a breech-loading gun requires more care in its use than a muzzle-loader, and a hydro-pneumatic mounting is not so simple as a carriage with an ordinary friction or hydraulic compressor, but experience with the 6-inch hydro-pneumatic siege carriage has shown that the system is capable of enduring very rough usage, and is by no means easily deranged.

The Australian colonies, acting under the advice of the late General Scratchley and General Steward, seem to be more intelligent and far-seeing than the mother country, and have acquired a considerable number of breech-loading guns, mounted on the system recommended, and carried out completely in all its details. It is difficult to see how official opposition can long brave the assaults made on it by common-sense, and the glaring defects of the old methods.

(To be continued.)

THE TEMPERATURE OF THE CLYDE SEA-AREA.

I.

IN the spring of 1886 a regular system of temperature observations was commenced in the water of the Clyde sea-area, by the staff of the Scottish Marine Station, under the personal superintendence of Mr. John Murray of the *Challenger* Commission. The work has since proceeded steadily, and will probably be continued to the close of the present year. Previous to 1886, few temperature observations had been recorded dealing with the deep water on the west coast of Scotland; these were almost entirely the work of Mr. J. Y. Buchanan on occasional summer cruises.

The scope of the present investigation is limited chiefly by the capabilities of the Marine Station's steam-yacht *Medusa*. She is a vessel of 30 tons, yacht measurement, steaming 6 knots in ordinary circumstances; but not adapted for working amongst the tremendous tidal currents of the North Channel except in the calmest weather. On the other hand, her small size, and the convenient arrangement of a steam-winch for working the sounding-line enables observations to be made with great rapidity in quiet water. Inside of Cantyre, soundings have been obtained in almost every kind of weather, and the present article will deal with this part of the west coast only.

The Clyde sea-area[1] comprises all the connected water-system, 1300 square miles in extent, lying to the north of a line drawn from the Mull of Cantyre to Corsewall Point in Wigtownshire. This line corresponds nearly to the 50-fathom contour; outside it the depth increases rapidly to over 80 fathoms; towards the inner or northern side it diminishes at first, and then remains at about 27 fathoms over an area of 270 square miles. This bank is termed the Clyde Barrier Plateau; it crosses from Cantyre to Ayrshire, past the south end of Arran, and around Ailsa Craig. The shallowest water covers a ridge at a depth of about 20 fathoms from the surface. The water deepens on the inside of the Plateau to form the Arran Basin, which in form resembles the letter λ, surrounding Arran on the west, east, and north, and running up into Lower Loch Fyne. The depth in this basin exceeds 50 fathoms over 100 square miles; the deepest water, 107 fathoms, occurs off Skate Island, near Tarbert. A much smaller depression runs in a straight line from the Cumbraes to Dog Rock at the mouth of Loch Goil. It is known as the Dunoon Basin, and has an average depth of 40 fathoms and a maximum of 56. Of the numerous lochs, reference will be made to two only, Upper Loch Fyne and Loch Goil. The former measures 25 miles from Otter Ferry to the head; it consists of a basin 30 fathoms deep, bounded by channels having an

[1] For detailed description and map see *Scottish Geographical Magazine* for January 1887.

average depth of less than 15 fathoms at Otter Ferry and Minard Narrows, and of a much longer and deeper basin beyond; the maximum depth of the latter (80 fathoms) is found off Strachur. Loch Goil, only 7 miles long and 47 fathoms deep in the centre, is cut off from the Dunoon Basin by a barrier rising to within 10 fathoms of the surface, and is thus exactly similar in its situation to Upper Loch Fyne. The average depth over the whole Clyde sea-area is 31 fathoms, and it contains approximately 150,000 million tons of sea-water. The estuary of the River Clyde is both narrow and extremely shallow, and the river does not appear to affect the Firth to such an extent as the Forth does the firth bearing its name.

The submarine features of the Clyde sea-area are varied and complicated; and this character is shared by the surface of the intervening land, producing a diversity of mountain, glen, and plain, and corresponding effects of sunshine, cloud, and mist, that lend to the temperature cruises a picturesque charm such as rarely invests physical research.

The cruises take place at intervals of about 50 days, and each occupies a little more than a week. Observations are repeated at about sixty stations, distributed over the whole area. The temperature is ascertained at the surface, at 5 and 10 fathoms, and at distances of 10 fathoms down to the bottom. Whenever a considerable difference is noted in the readings of two adjacent thermometers, observations are repeated at close intervals between them, so that when the curve of vertical distribution of temperature is drawn, points are most numerous where they are most wanted, at the regions of change of curvature. All temperature observations are made with Messrs. Negretti and Zambra's patent standard deep-sea thermometers. These are mounted in the Scottish frame, and are reversed by the fall of a brass messenger. Three thermometers are used on the line at once. The readings may be relied upon to one-tenth of a degree Fahrenheit, except when the sea is rough; then the very lively motion of the *Medusa* introduces a little uncertainty, on account of the difficulty of reading. A slight correction for change of volume of the detached column of mercury is necessary when the temperature of the water differs more than 5° F. from that of the air; the air-temperature being observed by the wet-bulb sling-thermometer.

A slip water-bottle is used on the line along with the thermometers, and samples of water are secured from various depths.

The entire set of observations made on the Clyde sea-area, up to November 1886, have been published in the last number of the Scottish Meteorological Society's Journal; and for the purpose of giving a general idea of the main results as yet ascertained, it will suffice to describe the varying seasonal conditions in three typical regions, and then to indicate the general distribution of temperature in the whole area throughout the year.

In the *North Channel*, near the Mull of Cantyre, observations could only be made on five cruises, and of these only two could be extended far enough to reach deep water, that of April 16, when the weather was remarkably fine, and that of September 22, when Mr. Mathieson, of Liverpool, was kind enough to give the use of his large steam-yacht *Oimara* for the purpose. The result of all the observations is shown graphically in Fig. 1. The distribution was always uniform from surface to bottom (except for a variation of not more than 1° in the superficial layer); and, as the accompanying figures show, there was a steady rise of temperature from April to September, while by December there had been a marked fall. It is noticeable that in all cases except December the surface water was a little warmer than that beneath; in December it was a little colder. Temperature:—

April 16	June 19	August 12	September 22	December 25
42°·0	47°·4	52°·5	54°·5	48°·5

The annual range, so far as observations go, appears to be about 12°·5 F. The uniformity of temperature throughout the mass of water continues over the Plateau, but gives place to a slightly different distribution in the deep Arran Basin.

Off *Skate Island* eight observations have been made between March 1886 and February 1887, and the curves presenting their results are given in Fig. 2. The actual figures observed for surface and bottom are:—

	March 27		April 19		June 21		Aug. 10
Surface	41°·4	...	43°·8	...	48°·3	...	53°·6
Bottom	41·5	...	41·3	...	44·0	...	45·6
	Sept. 26		Nov. 16		Dec. 29		Feb. 7
Surface	54°·7	...	49°·3	...	46°·6	...	43°·7
Bottom	47·4	...	51·1	...	47·4	...	44·3

The range of temperature on the surface thus appears to be 13°·3, and on the bottom 9°·8. The maximum surface

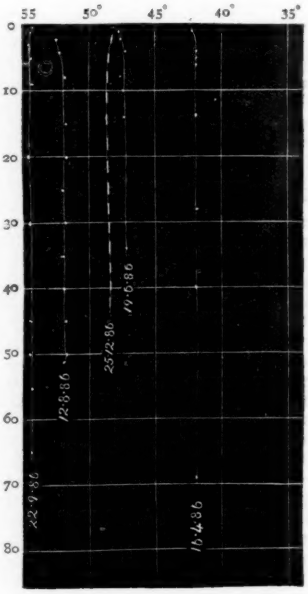


FIG. 1.—Channel.

temperature was observed in September, the maximum bottom temperature in November. The continuous curves (Fig. 2) show the course of heating; the broken lines that of cooling. They illustrate the development of conditions hinted at in the curves for the Channel. Starting with a practically uniform temperature of 41°·4 in March, the water had heated considerably on the surface, and cooled very slightly at the bottom, by April. From that time it warmed throughout, the surface most rapidly, and a mass of water next the bottom was warmed uniformly. The depth of this mass steadily decreased, until in September there was an unbroken gradient of temperature, falling from surface to bottom. By November the surface had chilled considerably; but at 24 fathoms the temperature was the same as in September, and below that depth higher; there being little change from 30 fathoms to the bottom. In succeeding months the fall of temperature has proceeded nearly uniformly, the curve approaching the form of a straight line, gradually becoming more nearly perpendicular. It will be noticed that the curves are not in all cases perfectly regular, but the deviations

are so slight that they might almost be attributed to errors of observation, or to the use of slightly erroneous corrections for the thermometers. This is not the true explanation, as the next group of curves illustrates.

Strachur is near the deepest part of Upper Loch Fyne; the water which the depression contains is cut off from communication with the outside by the double doors of Otter and Minard with a shallow hollow between. Eight sets of observations have been made, as follows:—

	April 20		June 21		Aug. 11		Aug. 25
	°		°		°		°
Surface	42·6	...	49·2	...	54·1	...	53·5
Bottom	41·9	...	44·1	...	44·2	...	44·2
	Sept. 27		Nov. 17		Dec. 29		Feb. 4
	°		°		°		°
Surface	52·4	...	46·4	...	41·0	...	43·0
Bottom	44·1	...	44·2	...	44·7	...	45·9

The surface range was 13°·1, with a maximum in August;

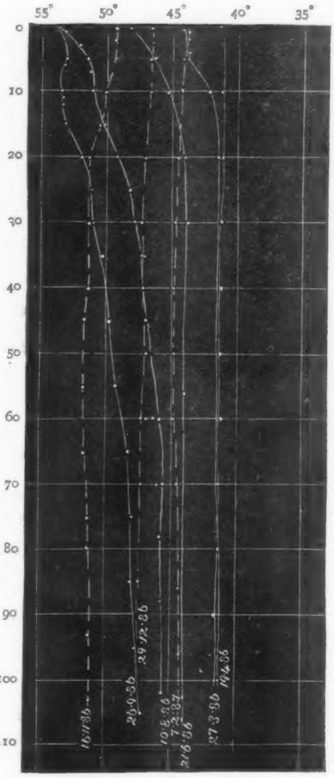


FIG. 2.—Skate Island.

the range of temperature on the bottom has as yet been only 4°; but it is impossible, until further observations have been made, to speak definitely about this. The most remarkable thing apparent from the above figures is that from June to December there should only have been a change of half a degree Fahrenheit in bottom temperature; but an examination of the curves in Fig. 3, will bring out some other curious relations. In April a uniform temperature of 41°·9 was found under 10 fathoms, and this was quite analogous to all the other April observations. In June the surface was found greatly warmed, but at 15 fathoms the temperature was only half a degree higher than it was two months before (42°·5): beneath that point there had been considerable rise of temperature (to 44°·1), so that the phenomenon was presented of a layer of cold water with warmer water above and beneath. It may be mentioned in passing that but for Negretti and Zambra's outflow thermometers this singular distribution could not have been traced out, perhaps not even detected; as, using the deep-sea thermometers on Sixe's principle, the natural induction would have been that below 15 fathoms the temperature was uniform at 42°·5. In August this minimum had almost disappeared, though a trace of it remained at 35 fathoms, the point where the August curve merges with that for June. By September surface cooling had begun, but below 2 fathoms and down to 50 there was

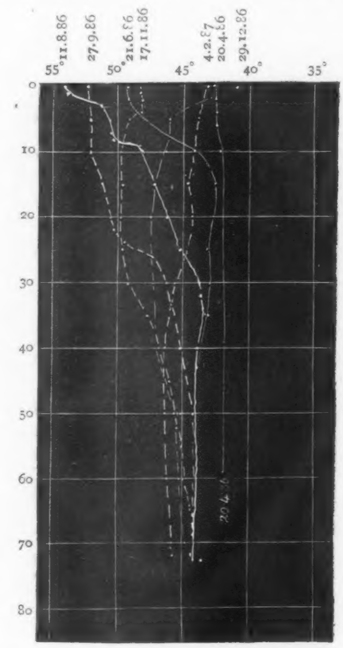


FIG. 3.—Strachur.

a rise of temperature. At the latter depth the temperature became constant to the bottom at 44°·2 as before. November and December showed the gradual cooling of the surface, and the still more gradual motion downwards of the point of maximum temperature. In December the bottom water had begun to warm, and in February the much attenuated maximum had reached to 45 fathoms, and the remains of summer heat had fairly influenced the bottom temperature. Many more very interesting relations will become apparent from the study of the interlacing curves of Fig. 3, which, with some modifications, are applicable also to Loch Goil, a rock basin "similar and similarly situated" to Loch Fyne.

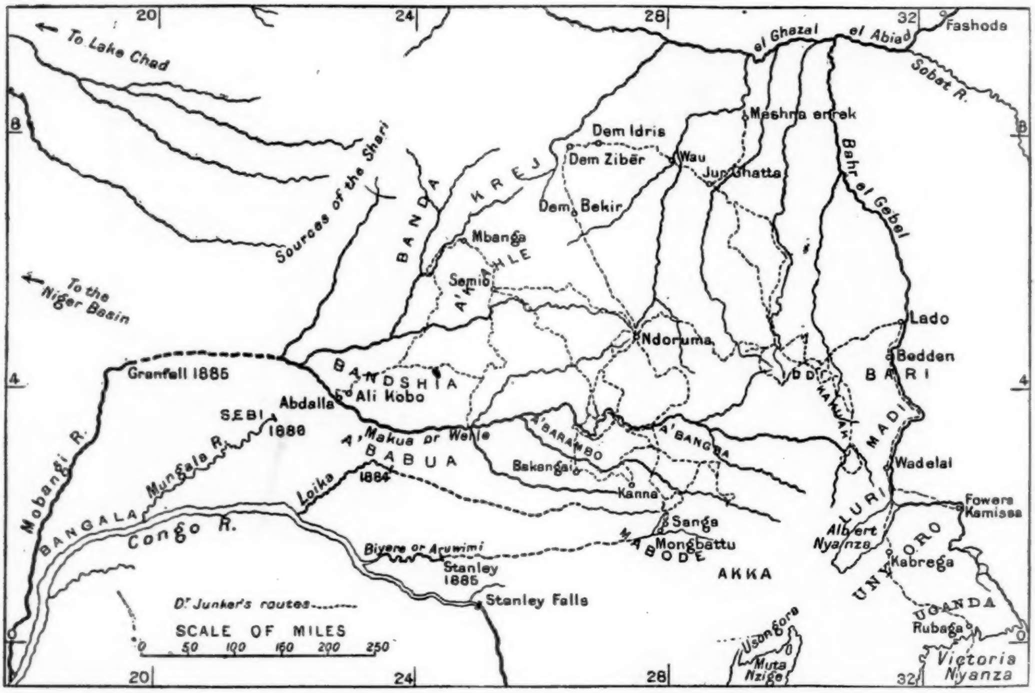
HUGH ROBERT MILL.

(To be continued.)

DR. JUNKER.

NOT since Greely told his story to the Royal Geographical Society has there been so crowded and enthusiastic an audience at Burlington Gardens as assembled on Monday night to welcome Dr. Junker, who, during the last ten years, has done so much good work for geography and science in the important region between the Upper Nile,

the Congo, and Lake Chad. Dr. Junker said little of himself and his own work on Monday night; he spoke mainly of the Mahdi rebellion and of his friend Emin Pasha. By the aid of the fine large maps which were shown (one of them drawn by Schweinfurth), and the few details which Dr. Junker did give, the audience obtained a fair idea of the extent and value of his work. Dr. Junker, who was born in 1840, and had an excellent scientific training at St. Petersburg, Göttingen, Berlin, and Prag, first went to Egypt in 1875, and between that and 1879 travelled extensively in the region of the Western Nile tributaries, as far as the Tondi and Wau affluents of the Bahr-el-Ghazal. On Monday night, however, he confined himself to the journeys of the last six years, which have been spent in exploring the Niam-Niam and Monbuttu countries, settling the problem of the course of the Wellé-Makua, and endeavouring to ascertain the watershed that divides the basin of the Congo from that of the Nile and Lake Chad. Dr. Junker's journeys have gone far to solve this problem, and to settle that the Wellé-Makua discharges its waters into the Congo through the Mobangi, which has been explored by Mr. Grenfell. As will be seen from the map, the region traversed by Dr. Junker is a complicated network of rivers, which it will take many journeys to unravel and chart with accuracy. To reach the field of his last six years' exploration, Dr. Junker went up the Bahr-el Ghazal to Djur Ghatta, and hence across the various southern affluents of the Ghazal to Dem-Zebehr, and then southwards to the town of Ndoruma, the powerful prince of the Niam-Niams. Junker's considerate and generous treatment of the natives gained for him a welcome wherever he went. Ndoruma may be said to have been his head-quarters, where he built his houses and planted his gardens, though he himself could not rest there for many weeks;



he was always eager to be on the march into new fields. While he was away exploring, his assistant Bohndorff occupied himself in preparing the natural history specimens collected; and it is sad to think that all this labour has been lost, as, partly owing to a fire and partly owing to the depredations of the Mahdi's people, none of these collections have reached Europe. After being established at Ndoruma, Dr. Junker made a journey of four months to the southwards, to the Monbuttu country, crossing the Wellé at two points. The details as to his discoveries on this and on subsequent journeys he reserves for the book which he hopes to write when he finds leisure. His next journey was in the same direction, to the country of the A-Mahdi, on the Upper Wellé, where he was detained several months. In November 1881, Junker was able to carry out his project of visiting the country of the Bakangai. From this time he was almost constantly on the march, and until June 1882 he was exploring the countries on the south of the Wellé. He made the acquaintance of many peoples whose language, manners, and customs differ essentially from those whom he had previously known. He was well received by the Niam-Niam princes, Bakangai and Kanna, to the south of the large river Bomokandi. Women are very differently treated among the Niam-Niams or A-Sandeh from what they are among the Monbuttus; among the former they are simply slaves, whereas among the latter they are in many respects treated on a footing of equality with the men. The Monbuttu women paint and tattoo their bodies in a most elaborate fashion, which Dr. Junker described in detail. When he left Prince Kanna and the southern A-Sandeh, Junker returned to the Monbuttu country, and spent some days at the station of Tangasi with the Italian traveller Casati. He then traversed the A-Bangba and Momfu countries to the south of the Wellé, crossed again the Bomokandi, and discovered the Nepoko, which he is inclined to identify with the

Aruwimi of Stanley. Here, while detained for months by a Monbuttu chief, A-Sanga, Dr. Junker suffered much from want of proper food and other causes. On the south of the Bomokandi he met with the pygmy people known as Akka or Tikki-Tikki, whom he found clever hunters, leading a nomad life. He was glad to get back to Tangasi to recruit. Crossing the Wellé in a north-west direction, he reached his new station at Semio's in September 1882. Setting out in December, he pushed southwards and westwards, touching the Wellé again at two different points, one of them being his farthest west point on this river.

The remainder of Dr. Junker's paper was occupied with the troubles caused by the Mahdi insurrection to his friends Emin Pasha and Lupton Bey. These troubles prevented Junker himself from proceeding to Europe northwards. He spent much time at Lado, where, under great difficulties, he constructed a large and beautiful map of his explorations. After being with Emin Pasha at Dufilé and Wadelai, and being detained for some time in Unyoro and Uganda, he at last persuaded King Mwanga to let him go. Crossing the Victoria Nyanza, he proceeded by one of the caravan routes to Zanzibar, and thence to Cairo, and so to Europe, where he arrived only a few weeks ago. Besides Dr. Junker's own paper, the only records of his ten years' work are a few letters which appeared at intervals in *Petermann's Mitteilungen*, so that his forthcoming work will abound with novelty. Its scientific value will be unusually great.

NOTES.

THE Royal Society's first *soirée* of the session was held last night. More trouble than usual had been taken to bring interesting things together, and the result was most satisfactory. We shall refer to some of the most striking objects next week.

WE print this week the firstfruits of a new organization for the furthering of astronomical research, which Mrs. Draper has established at the Harvard Observatory in memory of her husband. We do not think that a more noble memorial has ever been suggested to perpetuate the memory of any man, and certainly, if the fair promise of the opening work is kept up, Draper's name will go down to long distant ages. In addition to the first memoir, which we reprint, we have received from Prof. Pickering several enlarged copies of the stellar photographs already obtained. The scale of these photographs and their perfection will be gathered from the illustration which we give, and it does not seem too much to hope that within no very great number of years we shall possess photographs of the different orders of stars, with photographic spark comparisons, in which it may be quite easy to trace the lines due to the absorption of any particular element, and have, in fact, for stars of the various classes an exact equivalent of Ångström's *spectre normal* of the sun with the metallic coincidences. The friends of the late Henry Draper, and they are many in this country and on this side of the Atlantic, will thank his widow for the noble memorial she is erecting to his memory.

THE foundation-stone of the Imperial Institute will be laid by the Queen on Monday, July 4.

THIS afternoon the Croonian Lecture will be delivered before the Royal Society by Prof. H. G. Seeley, F.R.S. The subject is "*Parieasaurus bombidens* (Owen), and the Significance of its Affinities to Amphibians, Reptiles, and Mammals." On Thursday, May 26, the Bakerian Lecture will be delivered before the Royal Society by Prof. J. J. Thomson, F.R.S.

AT the general monthly meeting of the Royal Institution on Monday last, Prof. Tyndall was elected Honorary Professor of Natural Philosophy. Lord Rayleigh was elected Professor of Natural Philosophy.

THE visitation of the Royal Observatory at Greenwich takes place this year on June 4.

MR. WOODS, the President of the Royal Institution of Civil Engineers, and Miss Woods, have issued cards of invitation to a *conversazione* to be held at the South Kensington Museum on the 25th inst.

THE general meeting of the Institution of Mechanical Engineers will be held on Monday evening, May 16, and Tuesday afternoon, May 17, at 25 Great George Street, Westminster. The President, Mr. Edward H. Carbutt, will deliver his inaugural address on Monday evening. The following papers will be read and discussed, as far as time permits:—"On the Construction of Canadian Locomotives," by Mr. Francis R. F. Brown, Mechanical Superintendent of the Canadian Pacific Railway; "Experiments on the Distribution of Heat in a Stationary Steam-Engine," by Major Thomas English, R.E., of the War Office; and "On Irrigating Machinery on the Pacific Coast," by Mr. John Richards, of San Francisco.

ON Saturday evening next a lecture on "Savages" will be delivered by Sir John Lubbock in the New Schools, Oxford.

THE Deutsche Seewarte at Hamburg has published a chart showing the positions of the icebergs in the North Atlantic, compiled from reports received up to the middle of April. The chart is issued without charge to captains applying for it. As early as the first half of March several icebergs were met with south of 42° N. lat., and one even south of 41°. In drifting southwards, the icebergs, as always, are found between the meridians of 46° and 52° W.

THE fifth Bulletin of Miscellaneous Information, issued from the Royal Gardens, Kew, gives an account of bowstring hemp. This is not at present an article in commercial use, but Mr. J. G. Baker, the writer of the paper, thinks attention may well be directed to the capabilities of numerous species of *Sansevieria* for producing fibre of great value. Plants of *Sansevieria*, of which there are ten or twelve species, are very abundant on both the east and west coasts of tropical Africa, which, indeed, may be looked upon as the head-quarters of the genus. One well-known species (*S. zeylanica*) is indigenous to Ceylon; and this and others are found along the Bay of Bengal, extending thence to Java and to the coasts of China. The leaves of these plants are more or less succulent, and abound in a very valuable fibre, remarkable alike for fineness, elasticity, and for strengh. Mr. Baker gives a description of those species which are now under cultivation at Kew.

THE other day Dr. Robert W. Felkin, of Edinburgh, received three letters from Emin Pasha. The latest of them is dated Wadelai, October 26, 1886, and no more recent news from the writer has reached this country. Before starting for the coast from Uganda, Dr. Junker had collected a caravan and obtained permission from King M'Wanga to send it to Wadelai. "Besides bringing me a good quantity of cloth," writes Emin Pasha, "there were many presents from yourself, as well as newspapers from 1884 to 1886, a few books, *Graphics*, and, what pleased me most and will prove most valuable, a good many numbers of NATURE, so that at last I am permitted once more to see what is taking place in the scientific world." Along with this letter Dr. Felkin received a scientific paper which will be published in the *Scottish Geographical Magazine*. It is an account of a tour to the Albert Nyanza.

IT has been decided to remove the Royal Observatory of Brussels to Uccle, about 3½ miles to the south-west of its present position. The new buildings were commenced in September 1883, and are now so far advanced that the transfer of the instruments, &c., is arranged to take place next year. Observations

have already been taken at the new Observatory for about a year for the purpose of deducing corrections to be applied to the temperature-observations made in the town since 1833, to reduce them to the temperatures taken in the country.

A GERMAN mathematician has, from certain measurements effected, calculated that the quantity of snow which fell in Central Germany from December 19 to 23, between 50° and 52°·5 N. latitude and between 7° and 18° E. longitude, weighed no less than ten million tons.

THE Lord Mayor, sometime a member of the school, has arranged to be present at the opening, on May 24, of the new science and art buildings of Sir Andrew Judde's School, Tunbridge.

DR. F. DAY, F.R.S., author of "The Fishes of Great Britain and Ireland," will shortly publish with Messrs. Williams and Norgate his monograph on the Salmonidæ. It will be illustrated by coloured plates, and, in the first instance, be published for subscribers. It will be ready in July.

MESSRS. MACMILLAN will publish immediately a volume of "Essays and Addresses," by the Rev. J. M. Wilson, Head Master of Clifton College. The writer discusses the relation between ethical and theological questions and the ideas of modern science.

THE Council of the London Mathematical Society have sanctioned the issue of a complete index of all the papers printed in the Proceedings of the Society since its foundation. Seventeen volumes have been published. All persons who take an interest in mathematical researches and who wish to know what has been done by the Society in their respective branches are invited to apply to the Secretaries (22 Albemarle Street, W.) for a copy of the index.

The Clothworkers' Company of London have shown lately that they thoroughly understand the necessity for an improved system of technical education. At Dewsbury the Jubilee is to be celebrated by the establishment of a technical school, and the Clothworkers' Company have agreed to raise the local fund for the building and equipment of the institution from £10,000 to £11,000. In addition to this they have promised an annual subscription of £50 towards the maintenance of the school. The same Company, having contributed £3,500 to the fund for the erection of the Bradford Technical College, as well as £500 per annum towards its maintenance, have now promised to contribute £500 to a fund which is being raised to pay off the debt still remaining on the building. The additional buildings of the Textile Industries and Dyeing Departments of the Yorkshire College, now completed and equipped, were erected by the Clothworkers' Company at an expense of £30,000.

WE regret to learn that the amount of support given to the proposed memorial to the late Thomas Edward, the Banff naturalist, has been so small that the project is in abeyance; and the Committee are contemplating the return of the subscriptions received. It will be much to be regretted if some means of commemorating Edward cannot be found, similar to the John Duncan Prizes in the Vale of Alford. It will be remembered that a considerable proportion of the sum subscribed for Duncan in his old age was placed by him in the hands of trustees just before his death to found prizes for the encouragement of the study of botany in his own locality. Edward accomplished much more for science than Duncan, and it will be lamentable if no memorial of him can be established. Any persons who may wish to prevent the threatened abandonment of the memorial should communicate at once with Mr. John Allan, Town Clerk of Banff.

IN the *Monatsheft* of the Berlin Chemical Society (viii. 73) Dr. K. Olszewski has a paper on the "Absorption-Spectrum of Liquid Oxygen and of Liquid Air." On examining the absorption-spectrum of liquid oxygen with the help of a small direct-vision spectroscope—employing solar light—two strong dark lines were noticed in the orange and yellow portions of the spectrum, and these did not completely disappear after the volatilization of the oxygen. They were in fact found to be present in the ordinary solar spectrum, being faint at midday, but very distinct towards sunset. On employing greater dispersion, the oxygen absorption-lines expanded to bands like the telluric bands of the solar spectrum, and they were noticed, not only when solar light was employed, but also when the electric arc or the lime-light was made use of. In these experiments the oxygen layer was 7 mm. thick, and on increasing this to 12 mm. two more bands made their appearance; namely, a very faint one in the green, and another somewhat stronger in the blue. The positions of the four oxygen bands were determined with a Vierordt's spectroscope, the wave-length numbers being—

Band in orange	634—622
,, ,, yellow	581—573
,, ,, green	535
,, ,, blue	481—478

or, taking the middle of the lines, 628, 577, 535, and 480. Line 628 is distinguished by its breadth, and 577 by its intensity; the more feeble bands, 535 and 480, appear to be absent from the solar spectrum. With the view to determine the spectrum of the other main constituent of the atmosphere, pure nitrogen was not employed, but merely air carefully freed from moisture and carbonic acid. The spectrum of the liquefied air was examined under the same conditions as in the case of the oxygen, but no new bands made their appearance. The spectrum consisted merely of the bands 628 and 577 mentioned above, and these were but faint; they became stronger as the air became richer in oxygen through the volatilization of nitrogen, but were still far less intense than in the spectrum of pure oxygen. The determination of the absorption-bands of liquid oxygen is of importance in connexion with the discussion of the origin of the telluric lines of the solar spectrum. Janssen and Secchi have shown that most of these are due to aqueous vapour, and, according to Ångström, the bands which on account of their stability cannot well be due to aqueous vapour are A, B, α, and δ, the two latter coinciding with the two strongest oxygen bands. According to Egoroff, who recently examined the spectrum of compressed gaseous oxygen, the telluric bands A, B, and probably α, are due to oxygen. Janssen obtained similar results, but found also some other bands in the spectrum of compressed oxygen. Olszewski cannot confirm either the presence or absence of the groups A and B from the absorption-spectrum of liquid oxygen, as he has been unable to make exact observations in this part of the spectrum.

ANOTHER paper by Dr. K. Olszewski in the *Monatsheft* (viii. 69) is on the "Determination of the Boiling-Point of Ozone." It has been shown by Hautefeuille and Chappuis that when ozonized oxygen is exposed to a pressure of 125 atmospheres and to the temperature of boiling ethylene (−102°·5), the ozone is obtained in the form of a dark-blue liquid which retains the liquid form for a short time at the above temperature, after the removal of the pressure. It seemed, therefore, that the boiling-point of ozone could not be much below that of ethylene, and attempts were therefore made by Olszewski to liquefy ozone at the atmospheric pressure merely by the application of cold. At a temperature of −150° no liquid was obtained, the large proportion of oxygen present probably hindering the condensation of the small percentage of ozone. When a lower temperature (−181°·4) was employed—that of boiling oxygen—the ozone readily condensed to a dark-blue liquid. At this tem

perature it is transparent in very thin layers, but is almost opaque in layers 2 mm. thick. In order to determine its boiling-point, the tube containing it was introduced into a vessel containing liquid ethylene cooled to about – 140°. The ozone still retained the liquid form, and only began to vaporize when the temperature of the ethylene had risen to near its boiling-point. The temperature of the ethylene was determined by means of a carbon bisulphide thermometer, which at the moment of incipient ebullition of the ozone indicated a temperature of – 109°, this corresponding to – 106° of the hydrogen thermometer. The boiling-point of pure ozone is therefore approximately – 106°. Experiments with liquid ozone require great caution on account of the readiness with which explosions occur. If, for instance, liquid ozone comes into contact with ethylene gas, an extremely violent explosion occurs in spite of the low temperature. It is therefore necessary to exclude the inflammable gas from contact with the ozone, and then explosion need not be feared.

NOT less interesting than syntheses of vegetable or animal principles are the attempts which are made from time to time to build up minerals of the same crystalline form and chemical composition as those occurring upon the surface of our planet. One of the most widely distributed minerals—the historic magnetite—found so universally throughout the whole of the more basic rocks, and the square or triangular sections of which are familiar to every micro-petrologist, has long been a favourite subject for attempts, partially successful, at artificial reproduction. But probably the best method of effecting this has of late been devised by M. Alex. Gorgeu (*Comptes rendus*, No. 17, 1887), who has obtained fine crystals, sufficiently large to enable him to prove their complete identity with those of native magnetite. His method was to drop iron wire or filings into a bath of fused sulphite and sulphide of sodium, when a double sulphide of iron and sodium was formed, together with an oxide of iron richer in protoxide than magnetite; in a short time this oxidized to magnetite, and the sulphide and sulphite were converted to sulphate of sodium. The crystals of magnetite obtained, when washed free from the sodium sulphate, were a millimetre in section, of octahedral form modified by faces of the rhombic dodecahedron, and attracted by the magnet; they possessed the metallic lustre and the same specific gravity and hardness as crystals of naturally occurring magnetite.

WE have received the second edition of Miss Clerke's "Popular History of Astronomy during the Nineteenth Century," published by Messrs A. and C. Black. We regard it as a most encouraging sign of the times that in a period of not over eighteen months, the first edition of such a book as this should have been exhausted. It shows that the number of persons interested in astronomical science who care to read sound treatises requiring a considerable amount of attention is on the increase, and we know no book which is likely to foster the love of the subject among such people better than Miss Clerke's. The mere process of bringing up to date has involved the insertion of a considerable amount of new matter. Celestial photography naturally comes in for an added share of attention, directed chiefly to the discoveries of nebulæ in the Pleiades by the MM. Henry and Mr. Roberts; to the work in stellar spectral photography in progress at Harvard College; and to the preliminary essays in photographic charting made at Paris, Liverpool, and the Cape of Good Hope. Other new or extended passages relate to the bright-line spectra of γ Cassiopeiæ and β Lyræ, stellar photometry, the effects of tidal friction on the satellite system of Mars, and the daylight photography of the sun's corona. The theory of sunspots unfolded by Mr. Lockyer in his "Chemistry of the Sun" finds a place in the chapter on "Solar Observations and Theories," and that on "Solar Spectroscopy" includes an account of the observations of the spectra of sunspots at South Kensington, 1879–85, with their results for solar chemistry. We notice some modification in the author's views regarding the dissociation of terrestrial elements in the sun, the presence of the bright-line spectrum of oxygen in the solar spectrum, and Young's "reversing layer." She moreover (apparently on good grounds) withdraws the statement that comets, moving sensibly in the same track in the parts of their orbits near the sun, must have nearly identical periodic times. Paragraphs in the new edition are assigned respectively to the last comer (Comet 1887 I.) of the remarkable group connected with the comet of 1843, and to the singularities of Comet Pons-Brooks; while the observations on the meteors of November 27, 1885, on the new star in Andromeda, and at Grenada during the total eclipse of August 29, 1886, are fully particularized. We are glad to perceive that Miss Clerke has taken advantage of many of the hints of her critics, supplying, for instance, the few omissions in her work pointed out by Sir Robert Ball in NATURE (vol. xxxiii. p. 314). A completely new feature is a chronological table of the principal astronomical events between the years 1774 and 1887; and a frontispiece and vignette, reproducing Mr. Common's and the MM. Henry's photographs of the Orion Nebula, Jupiter, and Saturn, add to the attractions of the second edition.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mr. G. Lester; a Brazilian Tree-Porcupine (*Sphinghurus prehensilis*) from Brazil, presented by Dr. William Studart; a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented; a Domestic Sheep (*Ovis aries*, four-horned var.) from Arabia, presented by Mr. C. E. Kane; a Tooth-billed Pigeon (*Didunculus strigirostris*) from the Samoan Islands, presented by Mr. Wilfred Powell; a Great-crested Grebe (*Podiceps cristatus*) from Norfolk, presented by Mr. T. E. Gunn; a Goldfinch (*Carduelis elegans*), a Greenfinch (*Ligurinus chloris*), a Red Bunting (*Emberiza schœnichus*), British, presented by Master H. J. Walton; an Eyed Lizard (*Lacerta ocellata*) from Cannes, presented by Mr. J. E. Warburg; a Smooth Snake (*Coronella lævis*) from Hampshire, presented by Mr. H. B. Pain; a Green Turtle (*Chelone viridis*) from Ascension, presented by Dr. Keenan; a Squirrel Monkey (*Chrysothrix sciurea*) from Guiana, a Servaline Cat (*Felis servalina*) from West Africa, a Black-necked Swan (*Cygnus nigricollis*) from Antarctic America, two Natterer's Snakes (*Thamnodynastes nattereri*) from Brazil, purchased; four Prairie Marmots (*Cynomys ludovicianus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE MELBOURNE OBSERVATORY.—Mr. Ellery has recently issued his Annual Report referring to the year ending June 30, 1886. From it we learn that the new transit-circle has been in constant use during the year, and is in excellent order. There appears, however, to be a very gradual lowering of the west pier of the instrument since its erection in August 1884. There also appears a decided diurnal change in the level, the east pivot being higher in the morning and lower in the evening—probably due to the heating effects of the sun on the earth's crust, or on the building. The objects observed with the transit-circle during the year comprised fundamental clock stars, standard circumpolar stars, faint stars selected from the Melbourne zones, comet stars, refraction stars, and a list of stars proposed for insertion in the *Connaissance des Temps*. The great telescope was almost exclusively devoted to the revision of the southern nebulæ. During the year 214 of Sir J. Herschel's nebulæ were finally revised, 7 were searched for but not found, whilst 30 new nebulæ were discovered. There now remain only 95 nebulæ, which were observed by former observers, requiring final revision before publication. The photoheliograph was not in working order for several months during the year, owing to difficulties arising from the change in the size of the sun pictures

taken, from 4 to 8 inches diameter. The number of photographs of the sun obtained during the year was therefore only 92.

THE TRANSIT OF VENUS IN 1882.—Mr. Stone's Report exhibiting the results deduced from the British observations of the transit of Venus in December 1882 has been published. The resulting values for the sun's mean equatorial horizontal parallax from the different phases of the transit, are as follow:—

External contact at ingress $\pi = 8''.760 \pm 0''.122$
Internal ,, ,, ,, $\pi = 8''.823 \pm 0''.023$
,, ,, ,, egress $\pi = 8''.827 \pm 0''.050$ (α)
,, ,, ,, ,, $\pi = 8''.882 \pm 0''.043$ (β)

(α) or (β) are the values resulting from this phase according to the phenomenon selected to represent true contact. The mean of these gives for

Internal contact at egress $\pi = 8''.855 \pm 0''.036$
External ,, ,, ,, $\pi = 8''.953 \pm 0''.048$

The combination of the values deduced from the internal contacts at ingress and egress gives $\pi = 8''.839 \pm 0''.021$ or $\pi = 8''.825 \pm 0''.028$ according as (α) or (β) is used. In the mean from internal contacts $\pi = 8''.832 \pm 0''.024$.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 MAY 15-21.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on May 15.

Sun rises, 4h. 10m.; souths, 11h. 56m. 8·1s.; sets, 19h. 42m.; decl. on meridian, 18° 51′ N.: Sidereal Time at Sunset, 11h. 15m.

Moon (one day after Last Quarter) rises, 1h. 35m.; souths, 6h. 34m.; sets, 11h. 40m.; decl. on meridian, 12° 20′ S.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Decl. on meridian. ° ′
Mercury	3 49	11 3	18 17	13 33 N.
Venus	6 6	14 38	23 10	25 29 N.
Mars	3 59	11 36	19 13	17 33 N.
Jupiter	16 57	22 13	3 29*	9 27 S.
Saturn	7 40	15 48	23 56	22 13 N.

* Indicates that the setting is that of the following morning.

Occultation of Star by the Moon (visible at Greenwich).

May.	Star.	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image. ° °
19	29 Ceti	6½	2 52	3 50	63 260

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
T Cassiopeiæ	0 17·1	55 10 N.	May 20,		*m*
U Cephei	0 52·3	81 16 N.	,, 19,	2 38	*m*
R Sculptoris	1 21·8	33 8 S.	,, 17,		*M*
S Cancri	8 37·5	19 26 N.	,, 17,	20 28	*m*
U Ophiuchi	17 10·8	1 20 N.	,, 15,	0 16	*m*
β Lyræ	18 45·9	33 14 N.	,, 19,	2 0	m_2
R Lyræ	18 51·9	43 48 N.	,, 16,		*m*
R Cygni	19 33·8	49 57 N.	,, 21,		*M*
S Vulpeculæ	19 43·8	27 0 N.	,, 18,		*M*
η Aquilæ	19 46·7	0 43 N.	,, 19,	23 0	*m*
S Sagittæ	19 50·9	16 20 N.	,, 17,	1 0	*M*
T Delphini	20 40·1	15 59 N.	,, 20,		*M*
δ Cephei	22 25·0	57 50 N.	,, 17,	0 0	*M*

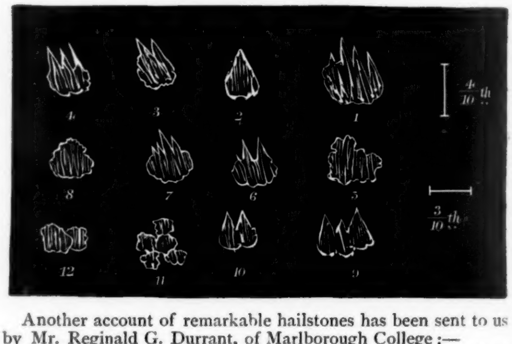
M signifies maximum; *m* minimum; m_2 secondary minimum.

Meteor-Showers.

	R.A.	Decl.	
Near α Coronæ	231°	27° N.	Rather slow and faint.
,, η Aquilæ	294	0	Very swift.
From Delphinus	315	15 N.	Very swift.

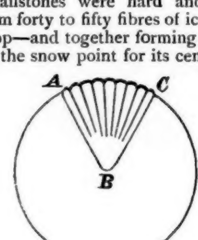
REMARKABLE HAILSTONES.

MR. E. J. LOWE writes to us from Shirenewton Hall, Chepstow, that remarkable hailstones fell there on April 5 from 1 55 p m. till 2 p.m. They were far apart, and fell with but little force, and were entirely opaque, and had a vertical cleavage. Some were conical, with an irregular base; some were spiked at the apex, and of these no two were alike; others were very irregular in form. A great number were composed of two or three united; in one case as many as five were fast together. The longest were four-tenths of an inch long, and three-tenths of an inch broad. They melted very slowly, lasting as much as two minutes. The temperature was 39°·5, wet bulb 35°·4, and temperature on grass 36°·7. The hailstones were quite different from anything that Mr. Lowe had ever seen. The accompanying figure records a few of them.



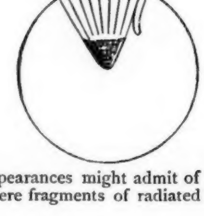
Another account of remarkable hailstones has been sent to us by Mr. Reginald G. Durrant, of Marlborough College:—

"On April 24, about 12.30," Mr. Durrant writes, "while walking between Melrose and Kelso, a friend and myself were overtaken by a sudden and very violent hailstorm, accompanied by thunder. The violent burst lasted about two minutes, in which time the ground was completely covered with large hailstones rather more than half an inch long. I say 'long' advisedly, for all the specimens I examined were conical, and were all of them formed in the same way. The points had all the appearance of snow, being softer than the main bulk of the 'stones.' These snow portions occupied about one-third of the whole length, being white and non-transparent. The main portions of the hailstones were hard and ice-like, stranded lengthwise with from forty to fifty fibres of ice—each fibre curved separately at the top—and together forming a curved surface, as of a sphere having the snow point for its centre. Thus—



Angle A B C of section between 50° and 60°.

"On melting, the pointed part became translucent, while the other part became more opaque than at first, strands often remaining for a time, partially separated and curving outwards, as though they had been freed from compression in their lower extremities. Thus—



"The above appearances might admit of the hypothesis that these hailstones were fragments of radiated crystalline spheres,

but one would expect in that case to find pyramidal rather than conical shapes, or at least to find some shaped so as to complement the cones. I failed to notice any indications of such shapes in the specimens (about thirty) which I examined. I should be inclined to believe that the soft, snow-like portions had been formed during the passage of the harder stranded stones through a moist and possibly clouded stratum of air.

"I was unable to see how they reached the ground, whether point or blunt end downwards. If in the latter way, one could account for the soft part, as being formed from previously unfrozen particles, cooled by contact with the nucleus, and, so to speak, sliding back to a position sheltered from the air, as it swept by the sides of the cone.

"But if the narrower end were foremost (and that would be the more natural position), then, unless the little mass—like an iceberg—could freeze particles in front of it before reaching them, it would seem that the snow point must have resulted from the accretion of small particles already frozen, and the pointed shape would be what we should expect. The only rotatory motion possible would be that in a plane perpendicular to the direction of the path through the air, and might account for the conical shape, the edges of any pyramid being rounded off."

M. A. Wentzil, of Izdebno, near Warsaw, writes to us of a hailstorm which occurred there on the 4th inst. "At 3 o'clock in the afternoon," he says, "hail began to fall, at first of small size, but in a few minutes the hailstones increased to the size of walnuts. Nine such which I picked up at hazard weighed together 13 lut (0·165 kilo). They were almost spherical with a mean diameter of $1\frac{3}{5}$ English inches. In the centre of each was a kernel of clear ice about the size of a pea, and from this kernel radiated conical masses of white ice, so that the surface of the hailstone was like that of a mulberry, the interspaces being filled with clear ice. The damage in the gardens and to glass panes was, as may be imagined from the size of the stones, considerable."

On March 3 we printed a letter from Mr. C. S. Middlemiss, describing a fall of top-shaped hailstones near Ramnagar, in the North-West Provinces of India (NATURE, vol. xxxv. p. 413). Writing to us on March 7, Mr. T. Spencer Smithson said (p. 438) that a fall of hailstones, almost exactly similar to those described by Mr. Middlemiss, had taken place in the neigbourhood of Rochdale on August 6, 1885. Mr. Smithson, however, pointed out that besides the horizontal stratification in these hailstones there was a perpendicular one, giving each hailstone the appearance of being composed of alternate cylinders of clear and white ice; and he asked Mr. Middlemiss to state whether the hailstones seen at Ramnagar had this peculiarity. Mr. Middlemiss now writes to us, in reply to Mr. Smithson's question, that the broad end of the hailstones showed no trace of any divisional planes whatever, being perfectly amorphous as originally stated. "The banded portion, so far as my memory serves me," he says, "may have possessed a faint longitudinal *striation*, just sufficient to run the bands together and to induce me to shade the diagrams vertically rather than horizontally, but I cannot be certain of it. It was not a marked feature, I feel sure."

SCIENTIFIC SERIALS.

Rivista Scientifico-Industriale, February.—The total solar eclipse of August 19, 1887, by Prof. Cacciatore. Prof. Tacchini having at the last eclipse established the presence round the sun of delicate white protuberances different from the ordinary rose-coloured protuberances daily visible under the spectroscope, it is announced that the Minister of Public Instruction will send Prof. Tacchini and Prof. Riccò to observe the August eclipse in Siberia for the express purpose of studying these new manifestations.—On the origin of the variations of intensity in the dry pile, and on the means of preventing them, by Prof. Luigi Palmieri. The author's experiments lead to the conclusion that the dry pile is not only the most durable, but also the most constant, and that the variations of intensity are due to dispersions. These dispersions are independent of the moisture and temperature of the surrounding atmosphere, at least within certain limits, while the pile enveloped in a volume of air will preserve its force almost unaltered for years, and not only not diminished, but even slightly increased, by the atmospheric moisture.

March.—A new method of measuring the specific weights of fluids, by Dr. Alessandro Sandrucci. A new method is described, for which a single apparatus alone is needed, and for which the author proposes the name of areovolumeter, combining as it does the functions of the areometer and volumeter. Although somewhat less accurate than Marangoni's recently invented double volumeter, this process reduces the disturbing influence of superficial tension to a minimum, while completely dispensing with the empirical scales on the volumeters, the determination of which involves considerable difficulty.

Bulletin de l'Académie Royale de Belgique, February.—Determination of the direction and velocity of the movement of the solar system in space, by M. P. Ubaghs. For the direction, the same method is adopted as that already known through the labours of M. Folie. For the velocity, use is made of three groups of stars of the second, third, and fourth magnitudes, the first group belonging probably to the solar nebula itself. The resulting velocity is only 16,500,000 kilometres for the year as compared with the 850,000,000 obtained by Homann working on the spectroscopic observations of Greenwich.—On the influence of diurnal nutation on the questions connected with the observations of γ Draconis made at the Observatory of Greenwich, by L. Niesten. By employing M. Folie's formula of diurnal nutation the author has determined a source of error long suspected in the calculations of Main and Downing. By introducing the necessary correction he arrives for the first time at a positive parallax for γ Draconis. He thus also, for the first time, determines beyond all doubt the real existence of diurnal nutation.—On the two tetrabromureted hydrocamphenes, by W. De la Royère. It is shown that by the action of the chlorobromide of phosphorus on camphor there are produced two tetrabromureted hydrocamphenes differing in their physical properties, specific weights, points of fusion, and molecular rotatory power. By subjecting them to the action of the nitrate of silver, heat, and chlorine, the author transforms the two isomeres into one and the same tribromureted camphene; while metallic silver reduces them to an identical bibromureted camphene, chlorine producing a bichlorureted and tetrabromureted hydrocamphene also identical for both.

Rendiconti del Reale Istituto Lombardo, February.—State of education in Italy, by Prof. A. Amati. The results of the recent official returns are given in tabulated form for the 284 circuits of the kingdom, showing in separate columns the percentage of "analfabeti" (illiterate) in each communal district and its chief town. The general result appears to be more unsatisfactory than had been anticipated, the disparity especially between the towns and rural districts being still excessive, even in Piedmont, Liguria, and some of the other best regulated departments.—Measurement of the muscular force in man, by Prof. G. Zoja. A brief account is given of the various instruments devised for determining scientifically the degree of muscular force in individuals, according to sex, age, and other conditions, from Regnier's dynamometer to the present time. The author also proposes a scheme of classification based on the degree of muscular energy possessed by the individual, and ranging from a given mean (Mesostheni) upwards and downwards through the Megastheni and Microstheni to the two extremes of Heraclestheni and Astheni.

March.—Observations on the luminous solar rays, by Giovanni Cantoni. The attention of meteorologists is called to the lucimeter recently constructed at Milan, which is stated to give more satisfactory results than the English heliograph with glass sphere or Craveri's chemical photometer. It determines with great accuracy the relative measure of the luminous rays at all hours of the day in relation to the altitude of the sun above the horizon of the place of observation. It also gives the integral of the successive and varying luminous influences of the sun during the course of a whole day. With regard to the instrument described by Clark in NATURE (vol. xxxii. p. 233) for measuring the radiant energy of the sun, its principle is stated to be based not so much on Wollaston, as on the discovery made many years ago by Bellani, and for some time applied by the author to agricultural meteorology.—Meteorological observations made at the Brera Observatory, Milan, for the month of February.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 21.—"Some Applications of Dynamical Principles to Physical Phenomena. Part II." By J. J. Thomson, M.A., F.R.S., Fellow of Trinity College and

Cavendish Professor of Experimental Physics in the University of Cambridge.

This is a continuation of a paper with the same title published in the Phil. Trans., 1885, Part II. In the first paper dynamical principles were applied to the subjects of electricity and magnetism, elasticity and heat, in order to establish relations between phenomena in these branches of physics. In this paper corresponding principles are applied to chemical and quasi-chemical processes such as evaporation, liquefaction, dissociation, chemical combination, and the like.

Many of the results obtained in this paper have been or can be obtained by means of the Second Law of Thermodynamics, but one of the objects of the paper is to show that there are other ways of attacking such questions, and that in many cases such problems can be solved as readily by the direct use of dynamical principles as by the Second Law of Thermodynamics.

A great deal has been written on the connexion between the Second Law of Thermodynamics and the principle of Least Action; some of these investigations are criticised in the first part of the paper, after this it is shown that, for a collection of molecules in a steady state, the equation (which for ordinary dynamical systems is identical with the well-known Hamiltonian principle)—

$$\delta(\overline{T} - \overline{V}) = 0,$$

is satisfied; where $\overline{T}$ and $\overline{V}$ are respectively the mean values of the kinetic and potential energies taken over unit time, and where the variation denoted by δ is of the following kind.

The co-ordinates fixing the configuration of any physical system, consisting according to the molecular theory of the constitution of bodies of an immense number of molecules, may be divided into two classes:—

(*a*) Co-ordinates, which we may call molar, which fix the configuration of the system as a whole; and

(*b*) Molecular co-ordinates which fix the configuration of individual molecules.

We have the power of changing the molar co-ordinates at our pleasure, but we have no control over the molecular co-ordinates.

In the equation—

$$\delta(\overline{T} - \overline{V}) = 0,$$

only the molar co-ordinates are supposed to vary, all velocities remaining unchanged. Hence in applying this equation we need only consider those terms in $\overline{T}$ and $\overline{V}$ which involve the molar co-ordinates. Expressions for these terms for gases, liquids, and solids are given in the paper; the rest of the paper after these have been obtained consists of applications of the above equation.

The density of a vapour in equilibrium with its own liquid is obtained as a function of the temperature, and the effect upon the density of such things as the curvature or electrification of the surface of the liquid is determined.

The phenomenon of dissociation is next investigated, and an expression for the density of a dissociated gas obtained which agrees substantially in form with that given by Prof. Willard Gibbs in his well-known paper on the "Equilibrium of Heterogeneous Substances."

The effect of pressure upon the melting-point of solids and the phenomena of liquefaction are then investigated, and the results obtained for the effect of pressure upon the solubility of salts are shown to agree with the results of Sorby's experiments on this subject. The effect of capillarity upon solubility is investigated, and it is shown that if the surface-tension increases as the salt dissolves then capillarity tends to diminish the solubility, and *vice versâ*.

The question of chemical combination is then considered, particularly the results of which is called by the chemists "mass-action," and of which a particular case is the division of a base between two acids.

The general problem investigated is that in which we have four substances, A, B, C, D, present, such that A by its action on B produces C and D, while C by its action on D produces A and B. The relation between the quantities of A, B, C, D present when there is equilibrium is obtained and found to involve the temperature; when the temperature is constant it agrees in some cases with that given by Guldberg and Waage, though in others it differs in some important respects. Thus, if ξ, η, ζ, ϵ be the number of molecules of A, B, C, D respectively, when there is equilibrium, θ the absolute temperature, H the amount of heat given out when the chemical process which results in the increase of ξ by unity takes place, and k a quantity which is the same for all substances, then it is proved that—

$$\frac{\xi^p \eta^q}{\zeta^r \epsilon^s} = \mathrm{CE}^{k\theta},$$

where C is a constant; p, q, r, s are quantities such that if (A) represents the molecule of A, with a similar notation for the other molecules, then the chemical reaction can be represented by the equation—

$$p\{A\} + q\{B\} = r\{C\} + s\{D\}.$$

Thus if A, B, C, D be respectively sulphuric acid, sodium nitrate, nitric acid, and sodium sulphate, in which case the reaction is represented by—

$$H_2SO_4 + 2NaNO_3 = 2HNO_3 + Na_2SO_4,$$

then, if the molecules of sodium nitrate and nitric acid be represented by $NaNO_3$ and HNO_3—

$$p = 1, \quad q = 2, \quad r = 3, \quad \text{and } s = 1.$$

If, however, the molecules of sodium nitrate and nitric acid are represented respectively by $Na_2N_2O_6$ and $H_2N_2O_6$, then since the chemical reaction may be written—

$$H_2SO_4 + Na_2N_2O_6 = H_2N_2O_6 + Na_2SO_4,$$

$$p = 1, \quad q = 1, \quad r = 1, \quad \text{and } s = 1.$$

According to Guldberg and Waage the relation between ξ, η, ζ, ϵ is—

$$\xi\eta = k\zeta\epsilon;$$

this, when the temperature is constant, agrees with the above expression if $p = q = r = s$.

We see that the state of equilibrium will vary rapidly with the temperature if H be large, that is, if the chemical process is attended by the evolution of a large quantity of heat.

The effect of alterations in the external circumstances such as those which may be produced by capillarity, pressure, or electrification are investigated, and it is shown that anything giving rise to potential energy which increases as the chemical combination goes on tends to stop the combination.

The last part of the paper is taken up with the consideration of irreversible effects such as those accompanying the passage of electric currents through metallic conductors or electrolytes. These are looked upon as the average of a large number of discontinuous phenomena which succeed each other with great rapidity. The ordinary electrical equations with the usual resistance terms in, represent on this view the average state of the system, but give no direct information about its state at any particular instant. It is shown that if we take this view we can apply dynamical principles to these irreversible effects, and the results of this application to the case of electrical resistance are given in the paper.

"On Parts of the Skeleton of *Meiolania platyceps*." By Sir Richard Owen, K.C.B., F.R.S.

The subjects of the present paper are additional fossil remains of *Meiolania platyceps* from Lord Howe's Island, transmitted to the British Museum since the author's previous paper on that extinct reptile. Additional cranial characters are defined and illustrated by drawings of more or less perfect specimens of the skull, of vertebræ of the neck, the trunk, and tail, of limb-bones, and portions of the dermal skeleton.

The author sums up the affinities, deducible from the above parts of the skeleton, to the orders *Chelonia* and *Sauria*, with grounds for the conclusion, mainly based on the absence of evidence of a carapace and plastron, that the genera *Megalania* and *Meiolania* are more nearly akin to the Saurian division of the class REPTILIA; in which he proposes to refer those extinct genera to a sub-order called *Ceratosauria*.

"Conduction of Heat in Liquids." By C. Chree, B.A., King's College, Cambridge. Communicated by Prof. J. J. Thomson, F.R.S.

Linnean Society, April 21.—Mr. W. Carruthers, F.R.S., President, in the chair.—Mr. E. M. Holmes exhibited specimens of various species of *Shorea* from Borneo and Sumatra, which plants yield vegetable fats used for technical purposes. Several species of *Dichopsis* affording gutta-percha from the bark and fat from the seeds were also shown. Mr. Holmes pointed out the importance of the cultivation of the more valuable of these trees, among others, *D. oblongifolia* and *Ceratophorus*

Leerii, since they are being rapidly destroyed by the natives. Their cultivation has already been commenced by the Dutch, but not a day too soon, as the trees take at least twenty years ere they are productive and valuable.—Mr. Patrick Geddes read a paper on the nature and causes of variation in plants and animals. The fact of organic evolution is no longer denied, but its physiological factors have not yet been adequately analyzed. Even those who regard natural selection as at once the most important and the only ascertained factor of the process admit that, such an explanation being from the external standpoint—that of the adaptation of the organism to survive the shocks of the environment—stands in need of a complementary explanation which shall lay bare the internal mechanism of the process, *i.e.* not merely account for the survival, but explain the origin, of variations. The relative importance of the external and internal explanations will, moreover, vary greatly in proportion as variations are found to be "spontaneous," *i.e.* in any direction indifferently, or "determinate," *i.e.* in some given direction continuously. Avoiding any mere postulation of an "inherent progressive tendency," common to both pre- and post-Darwinian writers, the definite analysis of the problem starts with that conception of protoplasm which is the ultimate result of morphological and physiological analysis, viz. to interpret all phenomena of form and function of cells, tissues, organs, and individuals alike in terms of its constructive and destructive ("anabolic and katabolic") changes. While the external or environmental explanation of evolution starts with the empirical study of the effect of human selection upon the variations of animals and plants under domestication, the internal or organismal one as naturally commences with the fundamental rhythm of variation in the lowest organism in nature. It also investigates the nature of the simple reproductive variation upon which the origin of species as well as individuals must depend, before attempting that of individual variations. The interpretation of all the phenomena of male and female sex as the outcome of katabolic and anabolic preponderance is shown largely to supersede the current one of sexual selection, and in some cases at least that of natural selection, *e.g.* the specially important one of the origin of such polymorphic communities as those of ants and bees. In such cases natural selection acts not as the cause of organic evolution, but as the check or limitation of it, and acquires importance rather as determining the extinction than the origin of species. The process of correlation, especially that between individualization and reproduction, is mooted by the author, and its application to the origin and modification of flowers, &c., outlined. A discussion is given of the embryological and pathological factors of internal evolution, with an application of the whole argument to the construction of the genealogical tree of plants and animals.—A report on the Gephyreans of the Mergui Archipelago, by Prof. Emil Selenka, of Erlangen, was read; this communication dealing chiefly with a technical description of species.

Zoological Society, April 28.—Fifty-eighth Anniversary Meeting.—Prof. Flower, LL.D., F.R.S., President, in the chair.—Many members of the Council and other Fellows of the Society were present. After some preliminary business, the report of the Council on the proceedings of the Society during the year 1886 was read by Mr. P. L. Sclater, F.R.S., Secretary to the Society. It stated that the number of Fellows on January 1, 1887, was 3146, showing a decrease of 47 as compared with the corresponding period in 1886. The total receipts for 1886 had amounted to £25,787 0*s.* 4*d.*, showing a decrease of £22 9*s.* 9*d.* as compared with the previous year. This slight decrease was mainly due to the falling off of the number of Fellows, and consequently of the receipts for subscriptions. The balance brought from 1885 was £972 8*s.* 1*d.*, making a total of £26,759 8*s.* 3*d.* available for the expenditure of 1886. The ordinary expenditure for 1886 had been £24,438 17*s.* 9*d.* Besides that, an extraordinary expenditure of £129 15*s.* had been incurred, which brought up the total expenditure for the year to £24,568 12*s.* 9*d.* The usual scientific meetings had been held during the session of 1886, and a large number of valuable communications had been received upon every branch of zoology. These had been published in the annual volume of Proceedings for 1886, which contained 716 pages, illustrated by 60 plates. Besides this, five parts of the twelfth volume of the Society's Quarto Transactions had been issued, thus making up all the arrears in this branch of the publications. A new edition of the Library Catalogue had also been prepared and issued. The Society's library now contained about 15,000 separate volumes. The "Zoological Record," which consisted of an annual volume containing a summary of the work done in the various branches of zoology in each year, would in future be published by the Society under the superintendence of a committee of the Council appointed for the purpose, and edited by Mr. F. E. Beddard, Prosector to the Society. The visitors to the Society's Gardens during the year 1886 had been altogether 639,674. The corresponding number in 1885 was 659,896. A slight alteration in the arrangements for the Davis Lectures on zoological subjects had been made for the present year. Mr. F. E. Beddard, Prosector to the Society, had been appointed Davis Lecturer, and had commenced a course of ten lectures on the Classification of Vertebrate Animals. The lectures were a continuation of a series given last year in connexion with the London Society for the Extension of University Teaching. The number of animals in the Society's collection on December 31 last was 2609, of which 777 were mammals, 1429 birds, and 403 reptiles. Amongst the additions made during the past year, 15 were specially commented upon as of remarkable interest, and in most cases as representing species new to the Society's collection. About 30 species of mammals, 20 of birds, and 3 of reptiles had been bred in the Society's Gardens during the summer of 1886. The report concluded with a long list of the donors and their various donations to the Menagerie during the present year.—A vote of thanks to the Council for their report was then moved by the Hon. J. S. Gathorne-Hardy, M.P., seconded by Mr. H. Berkeley James, and carried unanimously. The report having been adopted, the meeting proceeded to elect the new members of the Council and the Officers for the ensuing year. The usual ballot having been taken, it was announced that Sir Joseph Fayrer, K.C.S.I., F.R.S., Mr. John P. Gassiot, Col. James A. Grant, C.B., C.S.I., F.R.S., Prof. A. Newton, F.R.S., and Mr. Joseph Travers Smith, had been elected into the Council in place of the retiring members; and that Prof. W. H. Flower, F.R.S., had been re-elected President, Mr. Charles Drummond, Treasurer, and Dr. Philip Lutley Sclater, F.R.S., Secretary to the Society for the ensuing year. The meeting terminated with the usual vote of thanks to the Chairman, proposed by Sir Joseph Fayrer, K.C.S.I., and seconded by Mr. Herbert Druce, and carried unanimously.

Chemical Society, April 21.—Mr. William Crookes, F.R.S., President, in the chair.—The following papers were read:—The atomic weight of gold, by Prof. T. E. Thorpe, F.R.S., and Mr. A. P. Laurie.—The atomic weight of silicon, by Prof. T. E. Thorpe, F.R.S., and Mr. J. W. Young.—Note on substitution in the benzene nucleus, by Dr. H. Foster Morley.—Reply to the foregoing note, by Prof. Henry E. Armstrong.

Royal Microscopical Society, April 13. — Rev. Dr. Dallinger, President, in the chair.—Mr. T. C. White exhibited a series of photomicrographs which he had recently taken, showing the result of the method of cutting off some of the superfluous light by means of a sliding diaphragm so as to be able to admit just enough to bring out the detail and nothing more. The specimens shown were printed on Eastman's bromide paper instead of silver paper which he found brought out the character of the detail very much better.—Mr. F. R. Cheshire called attention to some specimens of bees, known as "fertile workers." It was generally well known that in the bee-hive all the eggs were usually laid by the queen, and in her absence no ovipositing occurs until they have taken some of the eggs remaining in the hive, and by a special feeding of the larvæ have been able to produce fresh queens. If, however, it should happen that in a hive which has lost its queen there are not eggs available for this purpose it was found that some of the workers under some special circumstances which could not be very clearly explained, became capable of laying eggs, but that such eggs produced drones only. These bees were known as fertile workers, and though there could be no doubt as to their frequent existence, they were very difficult to catch, owing to their being the same in appearance as the ordinary workers. He now exhibited two of these fertile workers having the ovaries drawn out of the bodies and attached to the stings and abdominal plates so as to show that they really were workers. There was a remarkable peculiarity to be observed in connexion with the ovarian tubes of these insects—every ordinary worker possessed an undeveloped ovary which it was very difficult both to detect and dissect, but when under the influence of some stimulus the worker became fertile, a number of points began to appear in the tubes which afterwards became developed, and it would seem that the eggs were

developed in alternation, an examination of the tubes showing them to contain developed eggs alternating with others in an undeveloped condition and of which some very curious instances were seen in the specimens before the meeting.—Mr. Crisp called attention to some photomicrographs of animalcules sent by Mr. J. B. Robinson; and to photographs of snow-crystals sent by Mr. Waters, from Davos Platz; also to a specimen of one of the earliest forms of the compound microscope by Campani, of Rome, made some time prior to 1665.—A new form of adjustable nose-piece, by Dr. Zeiss, was exhibited, in which the objective was made to slide in a groove in an inclined plane which insured its not scraping along the surface of the cover-glass when being changed.—A paper by Mr. P. H. Gosse, on twelve new species of Rotifera, was read.

Liverpool.

Biological Society, March 12.—Prof. Herdman, Vice-President, in the chair.—A paper was read by Mr. I. C. Thompson on some new and little known Copepoda of Liverpool Bay. The paper included the description of several new points in the anatomy of several species new to British seas.—Dr. Collins communicated some observations on anatomical abnormalities.—Mr. Harvey Gibson (Secretary) read the first of a series of notes on floral morphology, dealing with the angle of insertion of the petals on the thalamus in the *Polypetalæ* and the form of the flower as a whole in the *Gamopetalæ*, in their relation to the protection of the essential organs.

April 23.—Prof. Herdman, Vice-President, in the chair.—The Secretary (Mr. Harvey Gibson) read a preliminary paper on a research into the nature and function of the so-called "hepatic cells" of *Lumbricus terrestris*, by himself and Mr. A. J. Chalmers. The results so far tend to show that the so-called "cells" are rather digestive glands and not "vasifactive tissue" as suggested by some biologists.—Mr. G. F. Moore read a note on a new tank for the maceration of osteological specimens.—Dr. Herdman read a preliminary paper by Miss F. Palethorpe and Miss C. Wilson on a collection of Ascidians from Australian seas, sent by the Sydney Museum authorities to the Fisheries Exhibition, and containing a number of new species.—Dr. Bruce exhibited a collection of surface animals from Maltese seas, and Mr. R. McMillan exhibited a specimen of a pile from the works of the Canadian Pacific Railway, destroyed by the borings of *Teredo*.—Mr. G. H. Morton exhibited the spicules of sponges that he recently found in several places in the chert-beds of the Cefn-y-Fedw sandstone of Denbighshire and Flintshire, on the horizon of the millstone grit. Mr. Morton's observations have been confirmed by Dr. Hinde. The spicules probably belong to a genus of *Hyalonema*, and have not been recorded previously from North Wales.

Berlin.

Physiological Society, April 15.—Prof. Du Bois Reymond, President, in the chair.—Dr. Prause spoke on the degeneration of nerves resulting from sectional injuries. According to Waller, when a nerve is cut through, the peripheral parts degenerate, whereas the central remain intact. The result of a thorough investigation of the nerves in cases of amputation, which the speaker carried on some years ago in conjunction with Dr. Friedländer, has however shown that the central parts of the divided nerves had degenerated even right up to the spinal cord. Quite recently, Dr. Prause has repeatedly examined the nerves in cases where, owing to gangrene of the foot, the leg had been amputated close below the knee. Here the degeneration of the nerves extended up to, and probably beyond, the surface of amputation, having in such cases started from the gangrenous parts, and progressed centripetally. Side by side, however, with the larger number of degenerated fibres a few normal fibres were also found. From experiments on animals in which nerves of very different kinds, both sensory and mixed, were cut through, it appeared that in the peripheral parts by far the larger number of the fibres degenerate, while at the same time a not inconsiderable number remain unaltered; similarly degenerated and normal fibres were found in the central part of the nerve, only in this case the relative number of each kind is in an inverse proportion to that in which they are found in the peripheral part. It follows from the above that, starting from the point of section of a nerve, one set of fibres degenerates towards the periphery, the other towards the centre. It seemed right to assume that those fibres which degenerate towards the periphery have their trophic centre in the spinal cord or brain as the case may be, while those which degenerate centripetally are dependent for their nutrition on some centre at the periphery, such as presumably the tactile corpuscles of Meissner. Were this not so, Waller's law would again hold good, since only those parts of a nerve degenerate which are cut off from their trophic centre; only sensory nerves degenerate centripetally.—Dr. Grunmach communicated the results of some experiments on the relation between the curve of distension of elastic tubes and the rate of the pulse-wave in the same. These experiments were carried out with various gutta-percha tubes and with the aorta of horses; the internal pressure being varied from 0 to 200 mm. of mercury, the alteration of volume of the tubes and the rate of transmission of the pulse-wave were both measured. The results showed that the rate of the pulse-wave is most markedly dependent upon the distension-curve or coefficient of elasticity of the tube; this coefficient is, however, very variable with different tubes. The behaviour of a horse's aorta approximated to that of an india-rubber tube wrapped round with linen. The thickness of wall of the tubes and the size of their lumen was very slightly, if at all, altered by the varying pressure, and their influence upon the relationship of pressure and rate of pulse-wave was quite subordinate.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

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